COUNTY OF LANARK.

SECOND REPORT

ON THE

ADMINISTRATION OF THE RIVERS POLLUTION PREVENTION ACTS.

BY THE

COUNTY MEDICAL OFFICER.

1909.

GLASGOW:
PRINTED BY ROBERT ANDERSON, 142 WEST NILE STREET.

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To the Convener and Members of the County Council.

My Lords and Gentlemen,

A special Report, giving an account of the work done for the control and prevention of pollution of streams in the County of Lanark, was issued in April, 1903. Since then an account of the routine work has been given in the Monthly and Annual Reports of the County Medical Officer. As some recently-appointed members of the Council may not have seen the 1903 Report, and may have a difficulty in ascertaining the present position of matters, I have thought it desirable to bring up to date the more important facts contained in the 1903 Report relating to rivers pollution prevention.

Reference should be made to the valuable Reports of the Royal Commission appointed to inquire and report what methods of treating and disposing of sewage, including any liquid from any factory or manufacturing process, may properly be adopted. This Commission was appointed on 7th May, 1898, and from time to time the results of their inquiries and investigations have been issued. The fifth Report, dated 7th August, 1908, is, however, by far the most important to Local Authorities, and the summary of conclusions and recommendations contained therein have been reprinted and appended. That Report concludes—" We have dealt with the main question of what methods of sewage disposal may properly be adopted by Local Authorities. The remainder of our work will be chiefly concerned with the disposal of trade effluents when not mixed with sewage." In connection with their investigations anent methods available for disposing of trade effluents I received a communication from Mr. Colin C. Frye, one of the Chemists to the Commission, in June, 1908, enquiring as to the various kinds of liquid trade waste met with in the County, and stating that the Commission were already acquainted with

the work done in Lanarkshire up till 1903. A visit was arranged early in July, for the purpose of making some preliminary inquiries. Two days were spent by Mr. Frye, in company with one of the Rivers Inspectors, visiting public works, including the Mossend Iron and Steel Works, Carnbroe Iron Works, Glengowan Print Works, and Caldercruix Paper Works. Thereafter the Secretary received a list of the public works producing liquid trade refuse which seemed to have an interest for the Commission.

On 22nd December last a communication was received from the Secretary, stating that the Commission were then taking up the systematic investigation of the means available for disposing of trade effluents when not mixed with sewage, and asking me to give evidence on the question on a date towards the end of January. After consulting with the County Clerk, I suggested that he might deal with the legal aspects, and that I would deal with the technical aspects of any evidence which the Public Health Committee might think it desirable we should give. The Committee approved of evidence being given by the County Clerk and Medical Officer, who attended in London for that purpose on 6th February, and the Commission on 1st and 2nd April visited some of the more important works draining to the North Calder, as well as Clyde Iron Works, which drain direct to the River Clyde.

Reference might also be made to the Report recently issued by Mr. W. S. Curphey, Inspector for Scotland under the Rivers Pollution Prevention Acts. This Report deals with applications made by Local Authorities to the Secretary for Scotland, from April, 1897, up to the end of 1907, and in concluding his Report Mr. Curphey says:—

"It may be observed that, out of the thirteen applications made by Local Authorities under Section 6 of the Act of 1876, six were made by the County Council of Lanark, whilst the enquiry regarding the Airdrie North and the Airdrie South Burns was also associated with their action. The position taken by the County Council of Lanark in the question of prevention of river pollution may be ascribed to several causes. Prominent amongst these are the interest taken in the question by the County Council, and the favourable position it occupies in so far that the whole drainage area of the Clyde above Glasgow is within the jurisdiction of one Local Authority. It is thus possible for one authority to consider the pollution of the upper portion of the Clyde with its tributaries as a whole, and to deal so much the more effectively with the position. Only a portion of the work done in the department of prevention of river pollution by the County Council and its officers comes now under consideration. The

Medical Officer of Health for the County has referred to prevention of river pollution in his annual reports. and in 1903 made an interesting and complete report on the administration of the Rivers Pollution Prevention Acts within the area under the jurisdiction of the Lanarkshire County Council. It indicates what may be done by a Local Authority when its area of jurisdiction happens to approximate to that drained by a river passing through a manufacturing district."

I am,

My Lords and Gentlemen,

Your obedient Servant,

JOHN T. WILSON,
County Medical Officer.

County Offices,
Hamilton, *28th October*, 1909.

STAFF.

County Medical Officer.

John T. Wilson, M.D., D.P.H.

Chemist.

Walter Brown, F.C.S.

Inspectors.

Robert M'Naughton.

Frank M'Arthur.

Charles M'Ara.

County of Lanark.
Outline Map shewing the Chief Sources of Pollution affecting the River Clyde and Tributaries.
Sources of Pollution are indicated thus
Sewage Pollutions by Hatched Circles (the size of which corresponds with the population) and numbered to correspond with Table.
Manufacturing Pollutions by Solid Dots, the Circles representing Coal-dross Washers, and the Squares all others.
County Health Offices.
Hamilton, July, 1909.
River Kelvin
Luggie Water
Bothlin Burn
Mollin Burn
Garnkirk Burn
Bishopbriggs Burn
Partick
Glasgow
Govan
North Burn
South Burn
Luggie Burn
North Calder
Tollcross Burn
Shirrel Burn
Tillon Burn
Ladyland Burn
Currie Burn
South Calder
How Burn
River Almond
White Cart
Light Burn
Rotten Calder
Park Burn
Cadzow Burn
Kittoch Water
Auchter Water
River Clyde
River Avon
Gill Burn
Jocks Burn
Abbey Burn
Mouse Water
Dippool Water
North Medwin
South Medwin
Powmillon Burn
River Nethan
Douglas Water

I.—ADMINISTRATION.

Area, Population, and Valuation.—The area of the civil County of Lanark is 562,821 acres (Census 1901), and includes the City of Glasgow, besides ten other burghs. This area closely corresponds with the watershed of the River Clyde, which only becomes tidal as it approaches the eastern boundary of the City. The course of the river measures about seventy-five miles. This does not include two head streams, the Daer and Potrail, which, with the more important direct tributaries of the Clyde, have a course extending approximately to two hundred and thirty miles. The indirect tributaries have a very much larger mileage, and some of these are of importance from the point of view of rivers pollution.

The area of the administrative County of Lanark, in which the County Council have the same powers and duties as if they were a sanitary authority within the meaning of the Rivers Pollution Prevention Acts, is 540,879 acres, and excludes the City of Glasgow, with the ten other burghs after mentioned. The only stretch of the River Clyde not within the administrative County is that which flows through the City of Glasgow, but below this the river again flows through or by the administrative County in the landward portion of Govan Parish, so that the jurisdiction of the County Council extends along the south side of the River Clyde as far west as Renfrewshire. The stretch of the river through the City extends to about five miles, but for two miles above and two miles below the City boundary all pollutions liable to affect the River Clyde are dealt with in the Glasgow Sewage Schemes, and have, therefore, little administrative interest for the County Council. This area might therefore be called the Glasgow area.

The administrative County is divided into three sanitary districts—Upper, Middle, and Lower Wards—which have an area, population, and valuation as undernoted:—

Sanitary District.	Area.	Population.		Valuation, 1908-09.
		1901.	1907.	
Upper Ward, -	327,227	40,420	42,000	£360,993 13 0
Middle Ward, -	187,061	179,363	197,000	1,302,759 11 6
Lower Ward, -	26,591	41,531	52,000	310,648 19 2
County, -	540,879	261,314	291,000	£1,974,402 3 8

Mining and manufacturing industries are to be found in each of these sanitary districts, but by far the largest number is found in the Middle Ward area.

The corresponding information for the City and Burgh areas is, so far as available, given in the following Table, prepared from the annual return issued by the Local Government Board:

AREA, POPULATION, AND VALUATION OF THE CITY OF GLASGOW AND TEN BURGHS SITUATED IN THE COUNTY OF LANARK.

	Area.	Population.		Valuation, 1907-08.
		1901.	1907.*	
	Acres.			
Lower Ward—				
Glasgow, -	12,490	775,561	806,801	£5,901,970
Govan, -	1,303	82,174	93,093	468,783
Partick, -	956	54,298	67,362	401,319
Rutherglen, -	808	18,493	22,458	112,051
Middle Ward—				
Airdrie, - -	1,049	22,288	25,000	86,620
Coatbridge, -	1,845	36,991	43,710	205,174
Hamilton, -	1,332	32,775	38,950	161,644
Motherwell,	886	30,418	35,136	159,859
Wishaw, - -	919	20,873	23,048	81,597
Upper Ward—				
Biggar, - -	62	1,366	1,400	7,208
Lanark.	292	5,084	5,195	23,878
Total,	21,942	1,080,321	1,162,153	£7,610,103

*From the 13th Annual Report of the Local Government Board, 1907, Supplement containing Statistics.

Executive Authority.—Although every sanitary authority and County Council has power to enforce the provisions of the Rivers Pollution Prevention Acts in relation to any stream being within or passing through or by any part of their district, the County Council of Lanark has, since October, 1895, undertaken the administration of the Acts throughout the County. They have done so through their Public Health Committee, which is composed entirely of non-burgh members, as the expense connected with the administration of the Act is borne entirely by the non-burgh areas, viz.:—the three sanitary districts of the County. It will be remembered that County Councils in Scotland have no sanitary duties whatever in burghs, no matter how small the population of the burgh may be.

The recommendations of the Royal Commission as regards administration do not seem to affect the position of the County Council in so far as the River Clyde and its tributaries are concerned. The Commission recommend that a central authority should be appointed to act as supreme authority on all questions relating to water supplies and river pollution, and that local administration should be in the hands of a Rivers Board, who might be the County Council where the County embraces a whole watershed, or in other cases a specially constituted Board.

Expenditure.—The average annual expenditure incurred in the administration of the Rivers Pollution Prevention Acts in this county has up till now not exceeded £800 per annum. The smallness of the expenditure is no doubt largely due to the success which has attended the legal proceedings instituted against offenders.

Officers.—Since June, 1900, two inspectors appointed by the County Council have devoted all their time to this work, under the guidance of the County Medical Officer. One inspector assists occasionally. The analytical work necessary in connection with the sampling has been carried out in the laboratories of the County Council.

The following Tables show the number of inspections made and samples examined:—

SOURCES OF POLLUTION, INSPECTIONS MADE, AND SAMPLES EXAMINED, 1900-08.

Sources of Pollution.	Inspections.								
	1900	1901	1902	1903	1904	1905	1906	1907	1908
Coal dross Washers,	278	446	444	583	470	470	684	646	498
Ammonia Works,	32	76	50	88	101	93	96	135	115
Paper Mills,	13	15	14	27	31	46	33	44	31
Print, Dye Works, &c.,	8	29	7	19	14	17	10	20	10
Distilleries,	5	1	...	6	3	...	...	9	61
Lead Mines,		...	2	...	...	4	1	...	3
Preserve Works, &c.,		2	...	...	3	2	3	2	1
Total Industrial Inspections,	336	569	517	723	622	632	827	856	719
Inspections of Sewage Outfalls, &c.,	38	48	101	210	299	403	458	356	603
	374	617	618	933	921	1,035	1,285	1,212	1,322

SAMPLES EXAMINED IN LABORATORY.

	1900	1901	1902	1903	1904	1905	1906	1907	1908
Industrial Effluents,	3	35	87	101	51	53	7	47	50
Sewage Effluents,	265	4	49	77	55	130	69	275	64
Streams,	3	121	180	78	85	105	20	38	76
Totals,	271	160	316	256	191	288	96	360	190

LEGAL PROCEEDINGS.—Since the County Council undertook the administration of the Rivers Pollution Prevention Acts, seven actions have been raised in Court. The pollutions dealt with were—coal-dross washings, 2; spent ammoniacal liquor, 2; and sewage, 3. The sources of pollution and the results of the legal proceedings are here briefly summarised.

Stane and Kepplehill Collieries.—Action raised in 1901, and disposed of in 1905. Pollution admitted. Remedial measures carried out during progress of case. Remit made to man of skill to report to the Court on the efficiency of the remedy. Additional measures ordained to be carried out; silt recoveries provided. Interdict under Section 10 of the Act not granted, inasmuch as satisfactory remedial measures had been provided.

Westburn Colliery.—Action raised in 1902, and disposed of in 1905. Pollution proved, but the Court refused to grant interdict under Section 10 of the Act, inasmuch as remedial measures had been provided during the course of the case.

Clyde Iron Works.—Action raised in 1901, and disposed of in 1903. Pollution proved. Remedial measures which were at one time in use were brought into operation, and the spent ammoniacal liquor evaporated. Interdict granted.

Carnbroe Chemical Works.—Action raised in 1899, and disposed of in 1903. Pollution proved. Remit made to man of skill to report in terms of the Act. Remedial measures provided. Interdict granted.

Burgh of Motherwell.—Action raised in 1899, and disposed of in 1903. Sewage pollution proved. Remit made to man of skill to report to the Court on the provision of remedial measures. Burgh authorities ordained to provide purification works. One section of these works completed in 1908.

Burgh of Airdrie.—Action raised in 1905, and still in progress. Sewage pollution proved. Case decided in favour of the County Council by the Sheriff-Substitute, the Sheriff-Principal, and the First Division of the Court of Session. Appeal pending in the House of Lords.

Burgh of Coatbridge.—Action raised in 1905, and still in progress. Sewage pollution proved. Case decided in favour of the County Council by the Sheriff-Substitute, the Sheriff-Principal, and the First Division of the Court of Session. Appeal pending in the House of Lords.

Many interesting legal and technical questions were raised and disposed of in connection with those proceedings, the more important of which may be stated thus:—

(1) Were all parties to the action called?
(2) Had the County Council a proper title to sue?
(3) At what point on a tidal river does the definition of stream in Section 20 of the Act apply?
(4) Prescriptive right to pollute in respect of lapse of time, and whether a channel conveying sewage existing at the passing of the Act comes under the definition of stream?

(5) Where a stream forms a mutual boundary, but the bed of the stream is wholly outwith the pursuers' territory, can it be said that such a stream, by reason of its passing by pursuers' territory, is within that district?
(6) When a sewer admittedly discharges into a stream, does that constitute an offence under the Act, or must pollution be proved?
(7) What constitutes solid or liquid sewage matter?
(8) Where remedial measures have been carried out during the progress of a case in Court, should an Order be granted?
(9) Should appeal by Special case (which involves enormous delay) be abolished?

As some of these points are dealt with in the various interlocutors issued in the Airdrie and Coatbridge cases, liberty is taken to quote them here. Previous interlocutors in these and other cases will be found in the first Special Report on Rivers Pollution, and in the subsequent Annual Reports.

THE AIRDRIE CASE.

Airdrie, 13th July, 1908.—The Sheriff-Substitute having considered the cause: Finds in fact that (*a*) the Burgh of Airdrie, a town with about 24,000 inhabitants, discharges all its sewage into the North Burn, South Burn, and Brown's Burn, within the burgh boundaries, with the exception of a discharge by a sewer outside the burgh boundaries near to the point of issue of Brown's Burn: (*b*) as regards the North Burn, where it leaves the Burgh of Airdrie and enters the jurisdiction of the pursuers, (1) it is of a dirty grey colour, (2) supports sewage fungus on its bed and banks, (3) contains a large quantity of suspended matter, (4) has a characteristic sewage odour, (5) of the samples produced those most favourable to the defenders are found on analysis to contain 1·5 grains of chlorine, 0·224 of free or saline ammonia, 0·0784 of albuminoid ammonia to the gallon: (*c*) as regards the South Burn, (1) for a distance of about a quarter of a mile above the point where it enters the Burgh of Coatbridge its north bank, that is the bank in pursuers' territory, forms the boundary between the pursuers and defenders, and it does not, on leaving defenders' territory, directly enter that of pursuers, but enters directly the Burgh of Coatbridge, and enters pursuers' territory on leaving the Burgh of Coatbridge after its junction with another stream, (2) at the point where said burn touches pursuers' territory it is of a dirty grey colour, (3) supports sewage fungus on its bed and banks, (4) contains a large amount of suspended matter and sewage debris of all kinds, including solid excrement, (5) of the samples produced those most favourable to defenders on analysis are found to contain 4·23 grains of chlorine, 0·936 grains of saline ammonia, 0·014 of albuminoid ammonia to the gallon, (6) there is no evidence that where said stream enters the territorial jurisdiction of pursuers it is not polluted by sewage matter;

(*d*) as regards Brown's Burn, where it leaves the Burgh of Airdrie and enters the territorial jurisdiction of the pursuers, (1) it is of a dirty, dull grey colour, (2) supports sewage fungus on its banks and bed, (3) contains flocculent suspended matter, (4) has a characteristic sewage odour, (5) of the samples produced those most favourable to defenders are found on analysis to contain 2·3 grains of chlorine, 0·091 grains of saline ammonia, 0·04 of albuminoid ammonia; (*e*) (1) the substances disclosed by analysis are constituents of sewage, and are not ordinarily found together in water uncontaminated by sewage, (2) their presence in said streams in the amounts found is not accounted for by effluents from works, surface washings, or by the streams absorbing material from the strata through which they flow, (3) while a portion of these substances, particularly in the case of the South Burn, as regards the ammonia during the times when the gas-works is discharging it into the burn, may come from the sources mentioned, the main portion is attributable to domestic sewage; Therefore finds that (1) the North Burn and Brown's Burn, where they enter the territorial jurisdiction of the pursuers, and the South Burn, where it passes by the territorial jurisdiction of the pursuers, are polluted by sewage matter, (2) defenders are permitting sewage matter to fall or flow or be carried into the streams condescended on in the Petition: Finds that defenders are thus committing an offence against Section 3 of the Rivers Pollution Prevention Act, 1876: Repels all the defenders' pleas-in-law except No. 8, which meantime reserves: Before making a remit as directed by Section 10 of the said Act: Appoints parties to be heard as to the terms of the remit on Friday, 24th July, at 12.30 p.m.: Grants leave to appeal. (Signed) A. T. Glegg.

Note.—The proof in this case is limited to the averment "At the point where said burns and streams enter the territorial jurisdiction of the pursuers they are not polluted by any solid or liquid sewage matter." As there has been much controversy as to the limits of the proof allowed, I may explain the principle on which I gave rulings as to the admission of evidence. According to my view of the position of the case after the judgment of the First Division in the Special Case, and the subsequent Interlocutor of the Sheriff, the matter stands thus:—The defenders admit polluting the streams by sewage within their boundaries, and by this admission would be held as confessed if they had not made the averment quoted, to the effect that sewage pollution was not present at the point of discharge. Whether someone higher up than the defenders is polluting, so that the defenders receive a stream already polluted, is irrelevant. The pursuers are entitled to complain of pollution if defenders put in sewage, and if the stream is discharged in a polluted condition. Consequently the proof is not concerned with the condition of the stream higher up than Airdrie. If the point at issue had been, as some of the witnesses were led to think, whether the condition of the streams was worse on leaving Airdrie than on entering, evidence as to their condition above Airdrie would have been relevant, but that would have opened up a much larger field of enquiry. It is unnecessary for the pursuers to prove, since it is admitted, that the defenders discharge sewage into the streams within their boundaries, but since the defenders attribute the elements disclosed by chemical analysis to sources other than domestic sewage, or sewage of any kind, it is relevant for pursuers to show that sewage goes into the streams

in quantities and at places such as to make it more reasonable to attribute the substances discharged to sewage than to other cause.

With regard to the exclusion of the discharge from the sewer near Brown's Burn, it seems to me that, as that sewer discharges directly into the pursuers' territory, it does not fall under the proof allowed. It is not the dischaige of one of the streams mentioned on record, nor is it the discharge of a polluted stream. Although the discharge subsequently joins Brown's Burn, it is not part of Brown's Burn where it leaves the Burgh of Airdrie. It is not a natural tributary, but a sewer artificially led to the point of discharge.

The evidence led may conveniently be divided into three parts. First there is the physical appearance and the odour of the discharge; secondly, the chemical constituents; and, thirdly, the assignment of the cause for the presence of these constituents.

On the first point there is a considerable conflict, but I think it may be explained to a great extent by the circumstances under which the inspections were made. The defenders' inspection was made when the weather was admittedly showery, and the pursuers' when it was dry. Wet weather would, of course, increase the volume of the streams and increase the dilution, and a previous heavy flow of water would clean out the channels. Dry weather would, of course, have an opposite effect. I take it that the defenders' inspection was made when the streams were about their best, and the pursuers' when they were in a worse condition, though not necessarily their worst. Even their worst, in the height of a dry summer, might be sufficient for the pursuers' case, but the facts relied on by pursuers were not observed in such circumstances. The pursuers' evidence is that certain sewage, and the appearances, fungus, &c., which accompany sewage, were observed on certain dates, and the defenders' is that on a certain prior date these were not observed. There is no direct contradiction here, and both sets of observations may be held to be correct. In that case I should hold that the defenders had failed in their defence, but I am satisfied that pursuers' observations disclose better than the defenders' do the usual condition of the streams.

The initial fact in the case is that the sewage of a large population goes into these streams, all at a short distance above the point of issue from the burgh boundary, and some of it almost at the point of issue. No artificial means is taken to purify the streams so contaminated. The natural inference accordingly is that they continue contaminated, and the pursuers' evidence discloses what one would naturally expect. As these appearances were in fact, as I find, present on the occasions mentioned, I think that the pursuers' case might be held to be established without going further. A large amount of sewage goes in, a little further down actual sewage, or the usual appearances of sewage, are seen, and the streams are obviously polluted. Where actual sewage is seen there is no room for controversy, and where it is not seen in a solid condition the other appearances seem almost equally conclusive.

As defenders, however, maintain that a natural purification of sewage has taken place, and that chemical analysis establishes this, it is necessary to examine this part of the case also. The chemical analyses do not show any disparity which is serious, or which is not readily accounted for by the fact that the samples were taken at different times. They all show that the streams contain chlorine, free ammonia,

albuminoid ammonia, and suspended matter, which should not occur in any ordinary unpolluted country stream. Abnormal streams may contain some of these constituents from natural causes, not sewage, but no stream uncontaminated by sewage is stated to have these together as they are found here. But the defenders say, first, that these ingredients are not attributable to sewage; and, in the second place, if they are, that they do not show unchanged sewage, but only the products of sewage in a harmless form.

As to the first point, I do not think it can be said that sewage is negatived as the source of this foreign matter, and as this cause, the influx of a large amount of sewage, is present, there is certainly, to put it at the lowest, a heavy onus on defenders to show why this cause does not produce the result observed, and that some other cause does. In the solitary case of the ammonia going into the South Burn, they do explain the presence of part of the ammonia, though not all, but in so doing they explain the disproportion of saline to albuminoid ammonia, on which they rely for the negation of sewage. It seems to me so evident that domestic sewage accounts for the ingredients found that it is unnecessary to say more on this head.

As to the second point, I have some difficulty in appreciating exactly what the contention of the defenders is. It seems to proceed on the assumption that if the sewage is not found in the same chemical condition as when freshly produced it is not sewage matter. No doubt if a quantity of sewage is put into a relatively large body of water in a stream the stream will purify itself in the course of its flow, and a point will be reached when it can be said that sewage matter has been practically eliminated. No doubt also a body of water, prior to the influx of sewage, may contain ingredients which will precipitate the sewage and change it into something else. That to some extent happens here through the iron and lime in the stream, but the constituents by which sewage is chemically detected, the chlorine and ammonias, are still present, and the chemical analysis, so far as it can do so, does not negative, but asserts the continued presence of sewage. It may be, and probably must be, that these constituents are not found in the same proportions as in fresh sewage, but that is not to be expected, nor need fresh sewage be the basis of pursuers' complaint. It is not sewage, but pollution of a stream by sewage matter, which is complained of, and the samples taken are not taken from sewers, but from streams into which sewers flow. This mixture cannot be the same as the sewage itself (unless the stream were also fresh sewage), and consequently the analysis will not be the analysis of sewage, but the analysis of a sewage-polluted stream, or, stated in the other way, of sewage purified or altered to some extent by the stream. The question, therefore, is whether a process of change has gone on long enough or quickly enough to destroy the character of the foreign ingredients as sewage matter. I doubt if the defenders have made this out, even taking their own chemical evidence along with their admissions; and when I consider the pursuers' evidence, chemical and other, I have no doubt that defenders have failed. The defenders' case, as presented by their experts, comes to this, that they do not find chemically pure sewage in the samples—they find ingredients which may be the product of sewage; as they do not see actual sewage and the physical signs of sewage present, they say there is no evidence that these streams are polluted by sewage matter. On the other hand, the pursuers' experts say they find ingredients which

are always regarded as indicative of sewage; they saw actual sewage, or the physical signs of sewage, and, consequently, they say there is pollution by sewage matter. If defenders' witnesses had seen what pursuers' witnesses did see, I think their conclusions would have been different. The difference of the conclusions is explained by the difference in the facts observed.

It is necessary to point out that the Statute speaks of sewage matter, and not of sewage, and it is not to be assumed that the word "matter" is mere surplusage. It should get a meaning, and its natural effect is to extend the word "sewage" to something derived from or produced by sewage. I assume this product must have the character of sewage, but at what point this is lost it is not necessary in the present case to enquire. The word seems exactly suited to meet the defenders' contention in this case, and it seems to be introduced for such a purpose.

With regard to the question, whether the contamination proved amounts to pollution in the sense of the Act, there is no authority. Pollution is not defined, so that one has to take a popular standard. Here all the streams, and particularly the South Burn, are obnoxious to the sight, are in some small degree obnoxious to the smell, are incapable of supporting fish, and are useless for watering cattle or for washing of any kind. Indeed, no purpose was suggested to which they could be put, and they seem to merit the defenders' description of sewers. The defenders did not, I think, seriously argue that they were not polluted, but rather contended that the pollution was not due to sewage matter. The standard of purity they set up was that of a sewage effluent, and to this, apart from suspended matter, which in the South Burn is too great, it may be taken the streams conform, or nearly conform. This fact seems enough to conclude the case against defenders. Although public authorities have a practice of discharging sewage effluents into streams, I do not know that they have any right to do so if pollution is caused. But, in any event, the stream into which the effluent is discharged is not to be treated as the effluent itself. A stream receiving a sewage effluent ought to contain such a relatively large body of pure water that the mixture is not polluted. If communities were entitled to discharge streams flowing through their boundaries as sewage effluents, the present deplorable state of matters as regards river pollution could not be improved, and might possibly be aggravated. To say that the streams are no better than sewage effluents seems sufficient to condemn them as streams. It should also be remembered that these streams contain a large amount of suspended matter, a thing from which sewage effluents are free. Defenders contend that none of this is sewage matter, but I consider that the evidence is against them on this point.

The matter of the South Burn, which does not flow through pursuers' territory, is not expressly provided for in the proof allowed. It passes by that territory, because it touches it, and I have pronounced a finding in that view. It seems to me that Section 8 of the Statute, taken as a whole, confers a title to prosecute on an Authority where a stream passing by their territory is polluted during that passage. The later expression as to pollution in a stream passing through must be read as being satisfied by passing by, for otherwise the introduction of the expression "passing by" is meaningless. As pollution caused in a stream passing through confers a title, there is no need to require that it should also pass by, and if pollution on merely passing by does

not give a title the words are meaningless. The language of the section is difficult to construe, but I think it was obviously intended to give a right of complaint to an Authority whose territory is passed by, and the only intelligible meaning I can attach to the language is that a right to complain of pollution of such a stream is conferred.

The defenders naturally contend that proof on this point is not covered by the allowance by the First Division, but here they seem to be in a dilemma. As I read the judgment, the Sheriff was held to be right in finding against the defenders on all the points, except the one raised by the amendment of which proof is allowed. If this point does not fall within the amendment, the defenders fail to escape a renewal of the adverse finding. I think I might have proceeded on this view, but as the matter apparently was not raised in the Court of Session, and the defenders joined issue in the proof on this point, I have pronounced my finding in the form in which it is. As in either view my judgment is against the defenders, the form of the finding is not of much consequence.

The general finding that the defenders are permitting sewage matter to flow into the streams condescended on is pronounced on the same view of the Court of Session's decision. I am bound to exhaust the cause, and, therefore, to reaffirm the previous Interlocutor if I find against the defenders on the specific points raised in the proof.

(Intld.) A. T. G.

Glasgow, 30th December, 1908.—The Sheriff having heard parties' procurators and considered the cause, affirms the Interlocutor of 13th July, 1908, and remits to the Sheriff-Substitute to proceed in terms thereof. Meantime reserves the question of expenses.

(Signed) James G. Millar.

Note.—A great many questions were raised and discussed in this Appeal, but I think these have been narrowed down by the judgment of the Court of Session in this case, which is reported in 44 S.L.R., p. 915. Sheriff Guthrie by his Interlocutor, of date 10th April, 1906, repelled all the pleas for the defender except the eighth, and fixed a diet for hearing parties on the terms of the remit, as directed by Section 10 of the Rivers Pollution Prevention Act, 1876. In doing so the learned Sheriff held the defenders as confessed, and practically gave decree in favour of the pursuers. This decision was brought by Appeal on a Special Case before the First Division of the Court of Session, and the judgment of the learned Sheriff was practically sustained by the Court. The Lord President says—" The result, so far as I have gone at present, therefore seems to me this, that the learned Sheriff is perfectly right in holding that upon the face of the proceedings there had here been an offence committed, and that the Local Authorities of these two burghs could not take any help either, (first) from the fact that sewage was put in by persons whom they allege to a great extent had a prescriptive right to put it in, or (second) from the fact that they further said that other things went in which rendered the sewage innocuous."

But then he goes on to point out a matter which had rather escaped notice through the form of the pleadings, and the fact that the brunt of the contest in the Court below was upon the topics to which he had

already referred, and that was that the complaining Authority had only a title to sue, they not being in the district themselves, under the 8th Section of the Act, which he quotes. The offence having been committed outside of their district, they could only have a title to complain if there was pollution within their own district, and as the respondents averred that the streams were not polluted by them, that was a matter which must be enquired into. As the averment was not satisfactory, the respondents were allowed to amend, to the effect that at the point where the said burns or streams leave the territorial jurisdiction of the defenders and enter that of the pursuers they are not polluted by solid or liquid sewage matter. The Lord President further goes on to say—"Accordingly I think what your lordships ought to do is to send back the case to the Sheriff, with the intimation that is contained in our opinions that he should allow this amendment of the record, and allow a proof upon that specific point, and upon that specific point alone." Towards the end of his judgment he says "The matter is somewhat complicated, but I hope I have made it sufficiently clear that I think the Sheriff's judgment was completely right, with the exception that there was this question of fact which is disputed, and which underlies the whole matter of title. If that is cleared out of the way, I think the Sheriff's judgment is right." The effect of this opinion is that there is a very stringent injunction to this Court to take up the matter in the amendment, and that alone. If that be so, it seems to me that a large part of the argument that was addressed to this Court upon the Appeal was rendered useless. The only question before us now is the statement of the defenders that the streams when they leave their territorial jurisdiction are not polluted, and that being their statement the burden of proof clearly falls upon them.

On the amendment, the defenders raised two questions as to its meaning. The first was, what was the meaning of the word "polluted?" They attempted to explain it as meaning that from the time the streams had entered their burgh they had not added to the pollution. I think the terms of their own statement exclude the question whether the streams were more polluted when they left the burgh than when they entered it, and I am of opinion that the learned Sheriff-Substitute was right when he restricted the enquiry to the condition of the streams at the point where said burns or streams leave the territorial jurisdiction of the defenders. That leaves, however, the construction of the word "polluted," and I think light is thrown upon that by the Lord President's remark that their statement would lead to the conclusion that when the general liquid went out of the district of the first Sanitary Authority into the second's it emerged as a pure liquid. Accordingly, I think that the defenders must prove that when the streams leave their district the water in them, so far as solid and liquid sewage is concerned, was a pure liquid.

The second question that is raised is—What is the meaning of the words "solid and liquid sewage matter?" The pursuers maintain that that must include not only human and animal discharge, but must also include the discharge from industrial works. In other cases, no doubt, it has been determined that industrial discharge must be considered sewage, but I think it is plain from the judgment of the Court of Session that in this case it must be restricted to human and animal discharge, for this reason, that the Lord President refers to sewage and a great many chemical discharges and other discharges from works

as being separate from sewage, and that seems to me to suggest that the word must be taken in its more restricted meaning. There was also an argument as to whether you were to take unchanged sewage, or the animal and human discharge which had been affected by chemical action, so as to have become to some extent less noxious in its nature. The fair meaning, however, must be that all the matter which is in the water at the point with which we are concerned which is due to the introduction of animal and human discharge into the water, and prevents it being a pure liquid, must fall under the designation of solid or liquid sewage matter.

It is not necessary to go into the proof, because I have come, after reading it carefully, to be of opinion that the Sheriff-Substitute is right in his findings of fact with regard to the pollution of these streams. The main evidence for the defenders is that of their chemical experts, Drs. Drinkwater and Hunter. So far as I understand the point, they maintain that there is a ratio between certain of the chemical ingredients in real sewage which is well known. If, as in the present case, by the introduction of other chemicals the ratio may be disturbed, it is impossible to say from the strict chemical point of view that there is sewage in the water, and that, therefore, chemically they are entitled to say that this water is pure and free from solid or liquid sewage matter. This view, however, is contradicted by the chemical experts who were called for the pursuers; and, taking the general evidence into account along with the chemical, I have come to be of opinion that the Sheriff-Substitute is right in holding that, at the points where the streams leave the defenders' burgh, the water is polluted by solid and liquid sewage matter.

A point was taken that the question of pollution is a comparative matter, and that it is proved not only from the defenders' but from the pursuers' witnesses that the water at the points we are concerned with was no more polluted than the effluent from certain purification works, and that if that were so the pursuers could not ask for anything more. I agree with the view that was urged by the pursuers, that the effluent from a purification work which is to be introduced into a comparatively large body of pure water, and thus rendered innocuous, is quite a different matter from the water in a stream.

On the whole matter, I think the defenders have failed to prove their averment in the amendment upon the Record, and that, therefore, that removes the only difficulty in the way of the pursuers obtaining decree in terms of the opinions of the First Division.

The case, therefore, will go back to the Sheriff-Substitute for the purpose of carrying out the concluding part of his Interlocutor with reference to a remit under Section 10 of the Act.

(Intld.) J. G. M.

THE COATBRIDGE CASE.

Airdrie, 13th July, 1908.—The Sheriff-Substitute having considered the cause: Finds in fact that (*a*) the Burgh of Coatbridge, a manufacturing town of about 35,000 inhabitants, discharges all its sewage into the North Burn, South and Luggie Burns, and North Calder Water, within the burgh boundaries; (*b*) as regards the North Burn, at the point where it leaves the Burgh of Coatbridge and enters the territorial

jurisdiction of the pursuers (1) it is of a dirty white colour, (2) supports sewage fungus on its bed and banks, (3) contains a large quantity of suspended matter and sometimes solid excrement, (4) has an odour of sewage, (5) of the samples produced those most favourable to defenders are found on analysis to contain 1·55 grains of chlorine, 0·48 grains of free ammonia, 0·04 grains of albuminoid ammonia to the gallon, (6) these substances are constituents of domestic sewage, and are not ordinarily found together in water uncontaminated by such sewage, (7) their presence in the North Burn in the amounts found is not accounted for by effluent from works, by surface washings, or by ingredients absorbed by the stream from the strata of its bed, (8) while a small portion of said substances may come from the sources last mentioned, the main portion is attributable to domestic sewage; (*c*) as regards the Luggie Burn, at the point where it leaves the Burgh of Coatbridge and enters the territorial jurisdiction of the pursuers, (1) it is turbid and highly coloured, being of a dirty brown appearance, (2) it supports sewage fungus on its bed and banks, (3) contains a very large amount of suspended matter and sometimes solid excrement, (4) of the samples produced, those most favourable to defenders are found on analysis to contain 2·57 grains of chlorine, 0·44 grains of free ammonia, 0·04 grains of albuminoid ammonia to the gallon, (5) these substances are not found to the amounts above mentioned in uncontaminated streams, (6) these substances may be the product of domestic sewage or of manufactures, (7) in this case they are due to both causes, but are to be attributed to a large degree to domestic sewage; (*d*) as regards the North Calder Water, (1) the "medium filum" of this stream where the stream touches both the Burgh of Coatbridge and the territorial jurisdiction of the pursuers forms the boundary between them, (2) at a point about midway on this section of its course it receives an influx of sewage from a sewer leading from a group of houses connected with a work within the burgh, (3) this sewage is apparent in the stream at a distance of some ten yards below the point where it enters, (4) about this place the stream is turbid and somewhat milky in colour, (5) it contains more suspended matter than an ordinary uncontaminated stream, (6) analysis of a sample shows that it contains the usual ingredients of domestic sewage, (7) the presence of these ingredients is attributable mainly to domestic sewage. Therefore finds as regards the North Burn and the Luggie Burn, where they leave the Burgh of Coatbridge and enter the territorial jurisdiction of the pursuers, that they are polluted by sewage matter; and as regards the North Calder Water, that it is polluted by sewage matter where it passes by the territorial jurisdiction of the pursuers. Finds that defenders are permitting sewage matter to fall or flow or be carried into the streams condescended on in the Petition. Finds that defenders are thus committing an offence against Section 3 of the Rivers Pollution Prevention Act, 1876. Repels all the defenders' pleas except plea No. 5, which meantime reserves. Before making a remit as directed by Section 10 of the said Act, appoints parties to be heard as to the terms of the remit on Friday, 24th July, at 12.30 p.m. Grants leave to appeal. (Signed) A. T. Glegg.

Note.—I refer to the Note to the Interlocutor in the case of the County Council of Lanark against the Burgh of Airdrie of this date as to the admission of evidence, and generally as to the grounds of judgment and to the defences for the amendment.

On the first point, a word must be added with reference to the

North Burn during its course from the point where it leaves the burgh boundary to the point where after junction with the Gartsherrie Burn it recrosses it. I regard this part of its course as in the same position as its course above Coatbridge. The question to be tried is not what happens to it outside Coatbridge, but its condition on leaving that burgh.

With regard to the point whether the pursuers are entitled to cite the streams D and E on the plan No. 16/6 of process for the purpose of showing what an ordinary country stream is like, a nice question arises; but as pursuers have objected to evidence as to the condition of the streams higher up, and these tributaries are in the case of the Luggie Burn just a part of it higher up, I think the same rule should be applied.

The chief distinction between this case and the preceding is that there is here a large amount of effluent discharge from works going into the streams. It is not indeed proved how much or in what condition the discharges from the iron works, &c., do get into the streams, or how far these effluents are purified before getting in. No doubt the ammonias are recovered as far as possible from the discharges from the iron works. But, in any event, there must be a great amount of effluent from works getting into the streams, and this may account for part of the impurities found.

There is only a vague estimate, however, of the effect of this effluent in purifying the sewage in the streams. Indeed, it is not so much the trade effluents as the substances picked up from the soil which are relied on as purifiers. To some extent the various foreign ingredients other than domestic sewage will change the sewage, but it does not appear that they are present in such volume as to make the sewage disappear. So far as the chemical evidence, therefore, is concerned, it does not appear that the contamination of the streams is by any means attributable entirely to trade effluents. When the physical appearance, as noted by pursuers' witnesses, is considered, I think it is plain that the domestic sewage has not been got rid of.

The main pollution is that of the Luggie Burn. It receives most of the sewage and most of the trade effluent. The resulting compound is such that it is not contested that it is grossly polluted, but there is the usual allegation that what is found is the result of trade effluent. The chemical evidence cannot decide how much is due to domestic sewage and how much to trade effluent, but chemical analysis, consistent with the presence of domestic sewage matter and the other evidence, is overwhelmingly in favour of that view. The stream receives an enormous amount of sewage, and actual fæces are to be seen in it. There is abundant other evidence of sewage pollution. That being so, it is hardly open to defenders to argue that, certain of the facts being consistent with pollution from trade effluents, pursuers must prove that these are to be attributed, or to what extent they are to be attributed, to domestic sewage. If the defenders have mixed domestic sewage with trade effluent so as to make a division impossible, I do not think they can claim that they have shown that the stream is not polluted by domestic sewage. It is rather for them to clear up the confusion they have created. I therefore find that there is pollution from domestic sewage.

I am further of opinion that the pursuers are entitled to treat the mixed discharge of the sewers as sewage, though it is not necessary to

find to that effect. Though special provisions are contained in the Act of 1876 as to trade effluent, there is nothing to imply that a mixture of trade effluent with domestic sewage deprives the mixture of its character as sewage. Sewage is not defined in the Act, and a technical standard is not to be taken. The mixture contained in the sewers of towns is considered and treated by all Local Authorities as sewage, and I do not see why sewage should have a different meaning under this Act. If the trade effluent destroyed the domestic sewage there would be a different case, but most of it cannot have that effect. I do not gather from the proof that the chlorine or ammonia can have that effect. Iron will help; but taking that and the aids which the streams may have picked up from natural sources, there cannot be sufficient to destroy all the sewage this stream receives. These theoretical questions, however, hardly occur in this case, as the observations of actual sewage and the physical appearance of the stream, along with the fact that a large amount of domestic sewage goes in, seem quite sufficient to establish pollution by sewage.

The North Calder Water, at the point referred to, receives a sewer practically direct, and although this is a small affair compared with the others, it seems to be clearly a case of pollution under the Act. A succession of such contributions would be serious, and I think the pursuers are justified in attacking this one. At anyrate, taken by itself, it creates a local pollution, and that is sufficient.

(Intld.) A. T. G.

Glasgow, 30th December, 1908.—The Sheriff having heard parties' procurators and considered the cause, affirms the Interlocutor of 13th July, 1908, and remits to the Sheriff-Substitute to proceed in terms thereof. Meantime reserves the question of expenses.

(Signed) James G. Millar.

Note.—I do not think it is necessary for me to do more, so far as the general questions raised in this case are concerned, than to refer to the judgment in the action against the Burgh of Airdrie.

A question was raised in this case with regard to the South Burn that it does not emerge from the defenders' burgh, and that therefore no decree can be given with regard to it. As I have said in the Note to the Interlocutor in the other action, all these questions must be held to have been decided by the judgment of the late Sheriff Guthrie and by the opinions expressed in the Court of Session in the present action. The same thing may be said with regard to the pollution of the Calder Water at the point 7. In my view, the only question that remains is whether or not the defenders have proved their averment in the amendment on Record. All other questions seem to me to have been decided by the previous judgments.

The proof here is very much the same as the proof in the other case. On it I agree with the view taken by the learned Sheriff-Substitute, that taking the chemical and general evidence together the averment of the defenders has not only not been proved but has been disproved, and that at the various points mentioned on the record the streams are polluted with solid and liquid sewage matter.

Accordingly, I think the Sheriff-Substitute is right in holding that the defenders have committed an offence under the Rivers Pollution Act, and that he should proceed as proposed in his Interlocutor.

(Intld.) J. G. M.

OPINIONS OF THE FIRST DIVISION OF THE COURT OF SESSION IN SPECIAL CASES BURGHS OF AIRDRIE AND COATBRIDGE *v.* COUNTY COUNCIL OF LANARK.

Edinburgh, 4th June, 1909.—The Lord President said—My Lords, these two cases have come up to us again as Special Cases, and certain questions are asked in the case stated by the learned Sheriff.

My Lords, the cases went back to the Sheriff for the elucidation of one point, and one point only, which was raised by the new averment which the respondents have thought fit to make, viz., the averment that these streams of small volume into which admittedly the sewage untouched of two large towns was put, nevertheless at a space, I think, of something less than a mile below, entered the territory of the complainers in a pure condition. It did not seem likely that that averment could be proved, and I am bound to say that I do not think it has been proved.

The result of the enquiry has left no doubt upon my mind whatsoever that these streams are polluted by solid and liquid sewage matter. My Lords, I do not propose to go into the proof, because I think the matter has been admirably dealt with by the learned Sheriff-Substitute, and I really could not express better than he has done the result which I draw from the enquiry.

But the only seeming difficulty was the evidence that was given by the expert witnesses for the respondents. I can only say, my Lords, that on reading that evidence I can only reconcile it with accuracy by saying that the learned gentlemen set before themselves a construction of the words of the Statute, "polluted by liquid and solid matter," which is inconsistent with the most ordinary dictates of common sense.

Lord Kinnear—I concur.

Lord Guthrie—I also concur.

The Lord President—Then we will answer the questions in the affirmative, and the case must go back, of course, for the enquiry under the section.

Mr. Watson—I ask your Lordships for expenses in both cases.

The Lord President—Yes.

II.—INDUSTRIAL POLLUTIONS.

Lead Mining.—The mines at Leadhills have an altitude of over 1,300 feet O.S.D. They are situated in the Parish of Crawford, on the south-west boundary of the County, and have been worked for many centuries. The precious metals, gold and silver, have been found in small quantities, but the mining of lead is and has been carried on extensively by a company. The industry consists of (1) underground mining; (2) crushing, sizing, and washing ore; and (3) roasting and smelting the ore, the finished article being bars of lead. This last process has been discontinued since 1905. The metal as found is a lead sulphide, known as Galena, surrounded with stone consisting mainly of silicates. The raw material is first crushed and sized, then washed in order to separate the smaller particles of lead from the stoney material. The water used in the washery is obtained from a pure upland source. One portion of the water as it escapes from the washery is a turbid greyish liquid containing suspended matter in the proportion of from 300 to 600 parts per 100,000. Another portion, coming from what are known as the "jiggers," is only slightly turbid, and contains from 40 to 200 parts per 100,000 of suspended matter. The former liquid is passed through settling ponds, and deprived of the heavier particles, but the effluent, as it escapes, has from 150 to 200 parts per 100,000 of suspended solids. These solids are of a silicious nature, and contain traces of lead, but the clear water does not. After mixing with the liquid from the jiggers, the whole effluent is conveyed to the nearest stream, the Glengonnar Water, as it flows through the village of Leadhills.

This stream, after a course of about seven miles, joins the River Clyde near Abington. The grey, turbid effluent from these works has a marked effect upon the stream for some distance below the village, but does not seem to be of a noxious character, as fish have been caught in the stream just below the village. Some experiments were made in the laboratory which confirm this. Small fish put into the effluent itself have lived for a considerable length of time. The land through which the stream flows is largely used as sheep pasture, and the stream is so fenced off that the animals grazing cannot have access to it. The Glengonnar, in its lower reaches, and just before it joins the Clyde, sometimes bears evidence of pollution, as indicated by the bluish tint in the water.

This effluent has not been complained of, but may constitute an offence under Part III. of the Act, as the solid matter in suspension pollutes the water of the Glengonnar. The polluting effect is not merely discolouration, but the presence of solid matter in a fine state of sub-division. The question might be asked, what amount of suspended matter of this nature determines a pollution? This pollution could be greatly reduced by diminishing the amount of waste liquor discharged, and by increasing the settling area. The water, after being settled, could be pumped and used over again, as is done in coal-washing.

The settling which takes place in the ponds is very incomplete. Thus, on one occasion, the heavy washings entering the pond contained 639, and the effluent escaping 155 parts per 100,000 of suspended solids. These two samples were allowed to stand for half-an-hour in the laboratory, and the suspended solids in the supernatant liquid again estimated, when it was found that the former had only 32, while the latter had 67 parts per 100,000. The latter result is probably due to the fact that when the washings are deprived of the heavier solids in passing through the settling ponds the lighter solids do not so readily subside, but it may also be due to the fact that in passing through the settling ponds some of the fine silt is taken up. Further experiments show that even with complete quiescence the very fine particles take several hours to settle.

Roasting and smelting ore for the purpose of reducing the galena to pure lead was carried on at the smelting works, situated on the hillside about 1½ miles lower down Glengonnar Water. During this process the ore gave off a considerable quantity of sulphurous vapour, which was passed into a brick chamber, where, by means of a spray of water, the vapour was washed out and conveyed to settling ponds situated at the side of the stream.

In May, 1905, a serious complaint was made by the Angling Association, that several hundreds of trout had been killed. and the cause was attributed to discharges from the smelting works. Careful inquiry was made, and samples taken for analysis, with the result that while the effluent leaving the final settling pond was found to contain free sulphuric acid and a small quantity of lead, the stream itself, 15 yards below the outfall, contained no free acid, and the amount of lead was less than a tenth of a grain per gallon. Shortly after this the company stopped smelting operations, and I understand the galena is sold as such, and the roasting is probably done at smelting works in the North of England.

Coal Washing.—The number of washers in operation throughout the County has increased from 62 in the year 1900 to 72 at this date. See Table, pages 34-38. Three of these are situated in the Burgh of Hamilton, one of which has a drainage connection which is liable to affect the sewage purification works.

The process of separating small coal from impurities by means of water is not a mere washing operation as that term is usually understood, but an elutriation or separation according to specific gravity. Coal being lighter than clay and other earthy impurities, is readily separated from them by suitable appliances. The only washing done in the process is a final spraying of the coal after the separation has been effected. A considerable quantity of water as raised from the mine in a comparatively pure state, is seriously polluted in the washing operations, hence the interest such operations have from a rivers pollution prevention point of view. The quantity of polluted water discharged from a washer depends chiefly on the method and machinery employed, and also on the amount of impurities mixed with the coal.

The polluting character of the washings which escape is due to solid matter in suspension consisting mainly of clay and other earthy particles although in the earlier days of coal washing a large quantity of small coal was also present. The amount of suspended matter in the turbid liquid as it escapes from the washer varies considerably, but averages from 1,000 to 2,000 grains per gallon. When a sample is allowed to stand for two hours or so the suspended solids subside and form a deposit at the bottom of the vessel, the larger particles being lowest, and the very fine clay uppermost in the deposit.

Whether pollution by coal washings can be dealt with under the Rivers Pollution Prevention Acts depends upon the interpretation of the words which occur in Part III., Law as to Manufacturing and Mining Polution," Section 5 :—" Any poisonous noxious, or polluting solid or liquid matter proceeding from any mine other than water in the same condition as that in which it has been drained or raised from such mine."

And again in Section 20 :—" Polluting shall not include innocuous discolouration." In the application of these words to coal washings, I ventured the opinion in 1895 that " coal washings is a noxious and polluting liquid, inasmuch as it renders the stream unfit for primary purposes, domestic and agricultural. It is not a mere innocuous discolouration. The colour is due to particles in suspension."

The fifth report of the Second Royal Commission (1868) appointed to inquire into the best means of preventing pollution of

rivers might be referred to for evidence of the polluting character of coal washings. Regarding the effect of this form of pollution on fish life, the report of the Commissioners on Salmon Fisheries states:—"The fine detritus of coal washings may act as an irritant to the gills of the fish, and, by forming a deposit on the river bed, prevents the free passage of oxygen to the ova."

Experiments made with small fish in the laboratory did not show any injurious effect, although kept for many days in coal washings, but no doubt trout and salmon are more sensitive

It will also be remembered that Part I. of the Act, which deals with solid matter, does not seem to apply, as the definition clause states — "Solid matter shall not include particles of matter in suspension in water."

Many complaints have been received from time to time regarding pollution of streams by coal washings, and in the first action heard in the Sheriff Court, viz., that against Westburn Colliery Company in 1902, the Court held that "the defenders had habitually for many years prior to the raising of the action, and subsequent thereto, knowingly discharged into the stream noxious and polluting matter—to wit, the water used for washing the coal from stone and clay and other foreign matters, which water holds in suspension a large quantity of coaly matter—whereby the water in the stream is rendered unfit for primary and secondary purposes."

The modern method adopted for the prevention of pollution from the washer consists in the provision of a large tank, of a capacity sufficient to hold a whole day's washing, where the heavier suspended solids fall to the bottom, and are mechanically removed, while the water is raised by a pump and used over again. In this way the volume of dirty water to be dealt with is enormously reduced. In the earlier days only a very small proportion of coal washers were provided with silt-recovery tanks, or arrangements for using the water over again, but now 89 per cent. of coal washers have this mechanical arrangement.

The difficulties connected with the prevention of pollution at the present time relate not so much to the provision of proper settling ponds, but rather to their upkeep and proper management. The labour involved in cleaning out ponds, which may contain from 50 to 100 tons of silt, is considerable. At one colliery, where the ponds have a capacity of about 300,000 gallons, the cost of cleaning out the silt was stated to be about £150 per annum. It will probably be found desirable to frame such regulations for the control and management of the means of preventing pollution as would make it more easy to detect pollutions, and provide for a penalty which would tend to obviate their recurrence.

Drainage from Mines, etc.—In connection with mining operations there are two causes of complaint which cannot be dealt with under the Rivers Pollution Prevention Acts:—

(1) Water in the same condition as that in which it has been drained, or raised from the mine, and

(2) Drainage from refuse heaps existing long after mining operations have ceased.

Pit water, although exempted from the operation of the Act by Section 5, sometimes contains a sufficient quantity of solids to give the water a very turbid, polluted appearance. I understand that when the pit roadways are laid along a clay pavement the natural drainage becomes very turbid, and in such cases when it is raised from the mine the amount of suspended solids may reach 60 grains per gallon. At most collieries the sump at the pit bottom and any lodgment elsewhere, require to be cleaned out periodically. At such times the amount of suspended matter when the water is raised from the mine may be greatly increased. Much of the suspended matter readily separates from the liquid, but when discharged into a small stream the polluting effect is very marked. In one instance the colliery company voluntarily provided some means of settling.

Drainage from mines sometimes contains little or no suspended matter, but a large quantity of iron in solution. Even from a disused mine a large volume of water may fall or flow into a stream and produce a very turbid appearance. The clear water from the mine, and the clear water from the stream, when they meet, bring about chemical changes—the iron becomes insoluble, the water becomes turbid, and the bed of the stream is covered with a brownish deposit of iron.

Many refuse heaps contain iron pyrites in considerable quantity, and the drainage therefrom may also contain a considerable quantity of iron, producing similar results to that above described. In one instance, on the Shotts Burn, where the discharge went into a stream used for potable purposes, the water company laid an intercepting pipe from the refuse bing to a point below the intake of the water-works. These pollutions cannot be dealt with under Part III. of the Act, as the polluting liquid does not proceed from any factory or manufacturing process.

At collieries where the pit water is used for raising steam, the boilers require to be sludged frequently and thoroughly cleaned out once a week. On such occasions pollution is liable to occur from the large amount of suspended matter in the water run off from the boilers.

Ammonia Recovery.—The industries outside the Glasgow area provided with plant for the recovery of ammonia are given in the Table at page 39. There are, in all, 22 works with ammonia plant, and they might be classified thus:—coal-gas works, 5 situated in burghs and 1 in a drainage district; gas-liquor works, 1 in a burgh, 1 in a drainage district, and 1 landward; shale-oil works, 1; blast-furnace iron works, 5 situated in burghs and 4 in landward districts; coke ovens at collieries, 2; gas producer plant at iron and steel works, 1. All those situated within burghs or drainage districts are liable for drainage and sewage purification rates, but only two of them at present are connected to public sewers.

In the recovery of ammonia a considerable quantity of water is used to absorb and separate the ammonia from the vapours or gases, which contain other chemical substances of a poisonous nature, at present of no commercial value. These remain in the water after the ammonia has been removed, so that the waste liquor is a poisonous, noxious, and polluting liquid in terms of the Rivers Pollution Prevention Acts.

Two poisonous substances have been recognised in this waste liquor, viz.:—crude phenol (carbolic acid) and cresols. The former is the more important. A sample of liquor taken at an ammonia recovery plant connected with blast-furnace iron works just before the liquor was deprived of ammonia, contained 310 grains of phenols, and 500 grains of ammonia per gallon. This liquor, after it had been deprived of ammonia by passing through the sulphate-still plant, contained 280 grains of crude phenols, but less than 20 grains of ammonia per gallon. If this spent liquor is allowed to mix with other drainage at these works, and especially with tuyere water from the blast furnaces, the amount of phenols or poisonous substances is greatly reduced, but the liquor is still found to be of a polluting nature. Thus, in a series of 22 samples taken during 1901 at the drainage outfall from Clyde Iron Works, the amount of oxygen absorbed varied from 10 grains to 73 grains per gallon. This high figure was entirely due to crude phenols.

The effect of this form of pollution upon streams has been very noticeable, and even in the River Clyde itself was found to be destructive of fish life where no precautions were taken. Even where it is discharged into a sewage-polluted stream it retards natural purification. This is due to the rapidity with which spent liquor absorbs oxygen. Thus a liquor with only 4 grains of phenol absorbed over 7 grains of oxygen per gallon. In one instance where it was allowed to gain access to sewage purification works,

consisting of tanks and filters, the purification process was completely upset, and the amount of oxygen absorbed by crude sewage was 45; tank effluent, 36; and filter effluent, 10 grains per gallon.

No satisfactory method of purifying this liquor so as to render it non-poisonous has yet been introduced in this County. The ordinary precipitating agents, such as lime, sulphate of alumina, and salts of iron, have no such effect, but oxidising agents such as nitrite of soda diminish the amount of phenols. To obviate pollution by spent ammoniacal liquor it is therefore necessary that it should be so disposed of as not to enter a stream. Various methods are used to attain this end. Thus at gas-works the liquor is used for quenching the coke. At shale oil works the liquor is pumped on to the hot spent shale, and any that escapes evaporation trickles through the refuse heap. At blast furnaces, where there is usually plenty of gas to spare, the liquor is either evaporated in plant specially constructed for the purpose, or in the ordinary steam boilers. At the coke ovens and three of the iron works the liquor is disposed of by draining to a disused mine. At the gas-producer plant pollution takes place, and will now be referred to.

Mossend Iron and Steel Works.—This pollution was reported to the County Clerk on 21st February last, but no satisfactory remedial measures have yet been found. The gas plant, which is somewhat similar to the Mond and Duff gas producers, supplies heating power to the smelting furnaces and driving power throughout the works.

The water consumpt in this gas plant might be described under the heads—

1. Water in circulation, and
2. Water going to waste.

Water in Circulation. At the base of the air heating and saturating tower (which supplies moist, warm air for hot blast) there is a tank filled with water of a deep reddish-brown colour. This tank is replenished with fresh water as required, and there is an overflow to the drainage system. A sample at this point contained 13·6 parts of phenols per 100,000, and about 27 parts of acid. Any escape from here into the drainage system would therefore be of a polluting nature.

The water from this tank is raised by a pump to the top of the sulphate-house, where it is cooled. From there it gravitates to the bottom of the gas-cooling tower. After rising through this tower, it gravitates to the top of the tower first mentioned, thence falling into the tank, completes the circulation. So far no explanation was given as to how the water acquired its colour and

NORTH CALDER WATER AT DOUGLAS SUPPORT, SHOWING THE EFFECT OF POLLUTION BY SPENT AMMONIACAL LIQUOR.

Surface of water covered with froth

phenols, seeing it had not been brought into direct contact with the gases. This was explained upon ascending to the sulphate still house.

In the acid tower the liquor circulates in contact with the gases until it has acquired a sufficient amount of ammonia to be suitable for evaporation. It is then raised to the upper part of the sulphate-house, where the still, or evaporating plant, drives off under an exhaust the superfluous liquor. The exhaust is, I understand, created by a jet of water, whereby the water comes in direct contact with the vapour driven off from the still. The resulting liquor is conveyed outside to a small tank with an overflow pipe to the drainage system, but the bulk of the liquid is raised to the top of the sulphate-house, where the cooling of the liquid takes place. It then enters the circulation above mentioned, not as fresh liquid, but polluted with phenols and acid. This, then, was found to be the source of pollution of the water in circulation, and the question should be at once raised whether the present method of condensing the vapour could not be obviated. If this is practicable, then the overflow would not be objectionable, and to that extent would obviate pollution.

Water going to waste.—As the gases are cooled in their passage through the cooling tower they lose a considerable quantity of moisture, which flows through a tank at the base of the tower, and ultimately to the drainage system. A sample of this liquid contained 285 parts per 100,000 of phenols, and 58·8 parts per 100,000 of acid. This is a highly poisonous liquid, and is probably the chief source of complaint.

The analytical results of samples will be found in Appendix I., page 107. As there is no disused mine convenient to which the liquor could be conveyed, and as the gases are all required for power purposes, the preventive methods in use at other works are not available.

The effect of this pollution on the North Calder Water is shown on the illustration opposite this page. The surface of the water is covered with froth.

Surface drainage from works where ammonia is recovered is liable to contain a small quantity of phenols, as the ground surface becomes more or less polluted. The greatest quantity is to be found at those works where spent ammoniacal liquor is evaporated in ordinary steam boilers, but in most cases the pollution is so slight as not to warrant any special precautionary measures.

Paper Making.—The extensive works known as the Clyde Paper Mills, and the smaller works known as Eastfield Paper Mills, are situated within Rutherglen Drainage District, where all subjects are liable to drainage and sewage purification assessment. The effluents from these works will be received into an outfall sewer connected with the Glasgow south-side sewage scheme, and will be further considered under the heading, "Admission of Trade Effluent to Public Sewers." The two other paper mills are situated on the upper reaches of the North Calder Water, but about two miles apart, and are known as Caldercruix and Moffat Paper Mills, respectively.

The raw materials chiefly employed are wood pulp and rags. The wood pulp requires no special preparation, whereas the rags require a considerable amount of treatment in making them into pulp. In the manufacture of paper, other materials are added to the pulp, such as alum, clay, and dye stuffs. In the preparation of pulp the processes which give rise to effluents are (1) boiling and washing, (2) breaking and bleaching, and (3) beating. The alkali waste from the boiling and washing of rags or esparto grass is treated in an evaporating plant, so that the effluent from this source does not escape, but the effluent from the other processes discharges to settling ponds and is liable to contain a considerable quantity of suspended solids, as well as colouring matter in solution.

These suspended solids constitute a pollution under Part III., but by some it is considered doubtful whether the dissolved colouring matter also constitutes a complaint in respect that the definition clause states that the word *Polluting* "shall not include innocuous discolouration." It is necessary to prove that the discolouration is of a noxious character.

The means adopted for obviating pollution consist of settling ponds. At Caldercruix these have a capacity of 192,000 gallons, and are only cleaned out at considerable intervals. At Moffat Mills the settling tanks have only a total capacity of about 35,000 gallons, but the solids are removed daily to sludge pits, thence into filter presses, where, after the liquor has been pressed from the sludge, the solids recovered are stored, and the material thus collected is considered of sufficient value to meet a considerable portion of the expense of working the purification plant. There is also at these works a filtering area, but when coloured paper is being manufactured the effluent is sufficiently coloured to affect the river for many miles, and is sometimes a deep red colour.

Calico Printing.—This industry is carried on by one firm at the Glengowan Print Works situated on the uppermost reaches of the North Calder Water. The trade processes are numerous and elaborate, but might be classified as bleaching, printing, and dyeing, from all of which effluent is produced liable to cause pollution. The dissolved colouring material is the chief cause of complaint, and the means adopted for preventing pollution are briefly as follows:—the coloured effluent flows into brick-built tanks, where it comes in contact with sulphate of alumina. Further on it receives the waste alkali from the bleaching house, and then passes to the settling ponds, where the colouring matter is precipitated.

The liquid, before treatment, is of a deep brownish-red colour, turbid and opaque, capable of absorbing oxygen to the extent of 12 parts per 100,000, whereas after treatment the colour is yellowish brown, transparent, and slightly turbid, capable of absorbing oxygen to the extent of 1·4 parts per 100,000. These satisfactory results, however, are not always maintained. The total amount of waste liquor is estimated at one-and-a-quarter million gallons daily, but half of this does not require treatment, as it is simply clear water from cloth-washing.

Turkey Red Dyeing.—There is only one work where this industry is carried on, situated on the Clyde, where the Parishes of Rutherglen and Cambuslang are coterminous. Trade effluent arises in connection with washing in the preparation of the cloth or yarn, and with the dyeing of these materials the effluent is at times of a bright red colour. No preventive measures have been adopted, but as these works are situated within the Rutherglen drainage area, they will be liable to sewage purification assessment in connection with the Glasgow south-side sewage scheme.

Dyeing, Bleaching, and Finishing.—There are three works where dyeing is associated with bleaching and finishing. Two of these are situated in drainage areas and connected to public sewers, and the other is situated on the banks of the Avon near Larkhall. The effluent from this work consists of waste liquor from the bleaching-house, and of coloured liquor from the dye-house. The former is treated in a settling pond from which the supernatant liquid is drawn off automatically, and is led in a pipe to the mill-race. The latter is treated with sulphate of alumina in precipitation tanks, the outlet from which is controlled by a valve.

This liquor is only discharged at intervals by means of the pipe above referred to, so that it also finds its way into the mill-race in the form of a spray.

Bleaching and Finishing.—There are two of these works. One is situated in the Rutherglen Drainage Area, and will be connected to the outfall sewer of the Glasgow South-Side Sewage Scheme. The other is situated on the Clyde, near Carmyle. The trade effluent, however, from this work consists mainly of washings from finished cloth, and has not been found to be of a polluting character.

Chemical Works.—One of the largest chemical industries is situated at Shawfield, and carried on by the firm of J. & J. White, of which the late Lord Overtoun was senior partner. By a recent extension of burgh boundaries, these works are now situated in the Burgh of Rutherglen and will be connected to the outfall sewer of the Glasgow South-Side Sewage Scheme. Another chemical work, situated on the Luggie Water, has most of its buildings within the County of Dumbarton, but the means of preventing pollution are situated in the County of Lanark, near Cumbernauld. The Luggie Water is the mutual boundary between Dumbarton and Lanarkshire. The trade effluent arises largely in connection with the making of chrome. The preventive measures consist of a settling pond and filter. The final effluent, as it falls into the Luggie Water, is found to contain traces of chromium.

Distilleries.—Of these there are two. One, engaged in the manufacture of malt whisky, is situated in the Burgh of Wishaw, and has for many years been connected to the burgh sewer without any preliminary treatment. The burgh sewage is irrigated on grass fields near the banks of the Clyde. The other is engaged in the manufacture of yeast and Patent-still spirit. This distillery is situated near Garnkirk, and is connected by means of a long outfall sewer to a drainage district, thence to the Glasgow Sewage Works situated at Dalmarnock. Preliminary treatment on an elaborate scale is carried out at the distillery. Tanks, settling ponds, sediment house with drying chamber, and lime precipitation are all used to produce an effluent complying with the following conditions stipulated in the agreement for a connection to the sewer, viz.:—

The rate of flow or discharge of sewage from the distillery pipe into the District Committee's sewer shall not at any time exceed twenty cubic feet per minute.

The sewage shall be freed from all particles of matter in suspension and rendered perfectly liquid.

The temperature of the sewage shall not exceed one hundred degrees Fahrenheit.

The sewage shall be freed from acidity and rendered innocuous to sewage germs.

Admission of Trade Effluents to Public Sewers.—It has been the practice in the City of Glasgow, in Burghs, and in the Drainage Districts of this County, to allow most trade effluents to be connected to public sewers, and to consider the contents of such sewers as sewage. Ammonia works, discharging poisonous spent liquor; distilleries, discharging strong pot-ale; and other works with effluent difficult to treat separately, are among the industries in Glasgow connected to public sewers. The sewage conveyed to Dalmarnock Sewage Works, the first purification scheme provided by the City of Glasgow, consists more of trade refuse than domestic sewage. The restrictions laid down in connection with the admission of trade effluents to sewers in Glasgow are as follows:—

Glasgow Corporation (Sewage, &c.) Act, 1898, Section 30.—"It shall not be lawful for any person to send or permit to flow or pass into any sewers of the Corporation authorised by the Acts of 1891 and 1896 and this Act, or into any sewers or drains connecting therewith, any liquid substance or matter which would be injurious to the construction, maintenance, use, or efficiency of such sewers or of any sewage works of the Corporation, or which would cause, or be likely to cause, silting up, corrosion, or decay of the materials of such sewers or works, or to interfere with the efficient treatment of the sewage passing through such sewers; and every person offending against this enactment shall for every such offence be liable, on summary conviction by the Sheriff, to a penalty not exceeding ten pounds, and a further penalty not exceeding five pounds for every day during which the offence is continued after conviction thereof."

The effluent from paper mills in Rutherglen Drainage District was analysed and experimented with in order to determine whether it would cause silting up when discharged into the public sewer. As the suspended matter from a portion of one of the works was considered dangerous, arrangements were made for settling the suspended solids.

Standards.—In connection with trade effluents, this important question has not given rise to any serious discussion.

For coal-dross washings 30 grains per gallon of suspended solids was mentioned some years ago.

Spent liquor, as presently disposed of, is, with one exception, not allowed to enter any stream, and therefore requires no standard.

Coloured discharges from paper mills and print works are the most difficult to define as polluting liquids.

Table showing the Mining and Manufacturing Industries liable to cause Pollution, the Streams affected, and the Means adopted to prevent Pollution.

MINING.

1.—Lead Ore Washing.

Name of Work and Owner.	Situation, Drainage Outfall.	Means of Preventing Pollution.
Leadhills. — Leadhills Silver-Lead Mining and Smelting Company, Ltd.,	On Glengonnar, Leadhills,	Settling ponds. Water only used once.

2.—Coal Washing—Collieries.

Name of Work and Owner.	Situation, Drainage Outfall.	Means of Preventing Pollution.—When in operation indicated by an asterisk. Water reused	Silt Recovery Tank.	Settling Pools, &c.
Allanshaw.—Allanshaw Coal Co.,	On Cadzow Burn, Hamilton Burgh,	*	*	*
Allanton.—Wm. Barr & Sons, Ltd.,	On Allanton Burn, near Hamilton,	—	*	*
Auchengeich.—Jas. Nimmo & Co., Ltd.,	On Bathlin Burn, near Chryston,	*	*	*
Auchinlea.—Auchinlea Coal Co.,	On tributary of Tillon Burn, Omoa.	*	*	*
Auchlochan.—Auchlochan Coal Co.,	On tributary of Coal Burn, Coalburn,	*	*	*
Barblues.—A. & J. Anderson,	On How Burn, Harthill,	*	—	*
Bardykes.—Summerlee Iron Co., Ltd.,	On Spittal Burn, near Blantyre,	*	*	—
Bedlay.—Wm. Baird & Co., Ltd.,	On Tributary of Luggie Water, near Glenboig,	*	*	—

Name of Work and Owner.	Situation, Drainage Outfall.	Means of Preventing Pollution—Where in operation indicated by an asterisk.		
		Water reused.	Silt Recovery Tank.	Settling Ponds, &c.
Bellfield. — Wm. Barr & Sons, Ltd.,	On Coal Burn, Coalburn,	*	*	*
Bent.—Bent Coal Co., Ltd.,	On Cadzow Burn, Hamilton Burgh,	*	*	*
Blantyre No. 1. — Wm. Dixon, Ltd.,	On Park Burn, High Blantyre,	*	*	*
Bog. — Hamilton, M'Culloch, & Co., Ltd.,	On Clyde, near Larkhall,	—	*	*
Bogleshole.—Jas. Dunlop & Co., Ltd.,	On Clyde, near Tollcross,	*	*	—
Bothwell Castle. — Wm. Baird & Co., Ltd.,	On Clyde, Bothwell, -	*	*	*
Bothwell Park.—Wm. Baird & Co., Ltd.,	On Pow Burn, near Bothwell,	*	*	*
Broomfield.—James Nimmo & Co., Ltd.,	On Dalserf Burn, Netherburn,	*	*	*
Broomside.—Wishaw Coal Co., Ltd.,	On Clyde, Motherwell, -	*	—	*
Cadzow.—Cadzow Coal Co., Ltd.,	On Cadzow and Meikle Burns, Hamilton,	*	*	*
Camp.—Camp Coal Co., Ltd.,	On Clyde, Motherwell, -	—	—	*
Carfin.—Wm. Dixon, Ltd.,	On South Calder, Carfin,	*	*	*
Chapel.—Chapel Coal Co., Ltd.,	On Auchter Water, near Morningside,	*	*	*
Cornsilloch.—Archd. Russell, Ltd.,	On Mill Burn, near Larkhall,	*	*	*
Craighead.—Wm. Baird & Co., Ltd.,	On Clyde, Blantyre, -	*	—	*
Dalquhandy. — Waddell & Son,	On Coal Burn, Coalburn,	*	*	*
Darngavil.—Darngavil Coal Co., Ltd.,	On Cameron Burn, near Greengairs,	—	—	*

Name of Work and Owner.	Situation, Drainage Outfall.	Means of Preventing Pollution — Where in operation indicated by an asterisk		
		Water reused.	Silt Recovery Tank.	Settling Ponds &c
Dechmont.—Archd. Russell, Ltd.,	On Light Burn near Newton,	*	*	*
Dewshill. — Coltness Iron Co., Ltd.,	On Barbauchlaw Burn, near Shotts,	*	—	*
Douglas. — Coltness Iron Co., Ltd.,	On Douglas Water, Ponfeigh,	Luhrig washer not yet in operation.		
Douglas Park. — Wilsons and Clyde Coal Co., Ltd.,	On Clyde, near Bellshill,	*	—	*
Drumbow.—Dargavil Coal Co., Ltd.,	On tributary of Black Loch, near Longriggend,	*	—	*
Earnock.—John Watson, Ltd.,	On Earnock Burn, Hamilton,	*	*	*
Easterhill.—James Dunlop, & Co., Ltd.,	On Clyde, Tollcross,	*	—	*
Eddlewood.—John Watson, Ltd.,	On Cadzow Burn, Hamilton,	*	*	*
Ferniegair.—Arch. Russell, Ltd.,	On Clyde, Ferniegair,	*	*	*
Fortrigg.—Baton Collieries, Ltd.,	On Almond, near Shotts,	*	—	*
Gateside.—Flemington Coal Co., Ltd.,	On Gateside Burn, Cambuslang,	*	*	*
Gilbertfield.—United Collieries, Ltd.,	On Light Burn, Newton,	*	*	*
Glen Cleland. — Kerr and Mitchell,	On South Calder, near Cleland,	*	—	*
Greenfield. — Archd. Russell, Ltd.,	On Park Burn, Hamilton Burgh (drains to sewage works),	*	*	*
Hallside.—Jas. Dunlop & Co., Ltd.,	On Newton Burn, Newton,	*	*	*

Name of Work and Owner.	Situation, Drainage Outfall.	Means of Preventing Pollution—Where in operation indicated by an asterisk.		
		Water reused.	Silt Recovery Tank.	Settling Ponds, &c.
Hartwoodhill.—Shotts Iron Co., Ltd.,	On Ladyland Burn, Hartwood,	*	*	*
Hassockrigg.—Coltness Iron Co., Ltd.,	On Almond. near Shotts,	*	—	*
Hattonrigg — Summerlee Iron Co., Ltd.,	On Shirrel Burn, Bellshill,	*	*	*
Hillhouseridge —Baton Collieries, Ltd.,	On Currie Burn, Shotts,	—	—	*
Holytown.—James Nimmo & Co., Ltd.,	On Shirrel Burn, Holytown.	*	*	*
Home Farm. — Hamilton, M'Culloch, & Co., Ltd.,	On Merryton Burn, near Larkhall,	—	*	*
Kepplehill. — Kepplehill Collieries, Ltd ,	On Blind Burn, Shotts,	*	*	*
Kirkwood. — United Collieries, Ltd.,	On Luggie Burn, near Langloan,	*	*	*
Law. — Wilsons & Clyde Coal Co., Ltd.,	On Garrion Burn, Law Junction,	*	—	*
Lochend.—Jas. Nimmo & Co., Ltd.,	On tributary of Stirlingshire Avon and Black Loch, near Longriggend,	*	—	*
Milnwood. — Coltness Iron Co., Ltd.,	On South Calder, Bellshill,	*	—	*
Monkland.—Jas. Dunlop & Co., Ltd.,	On Brown Burn, near Airdrie,	*	*	*
Nackerty. — United Collieries, Ltd.,	On Ravel Burn, near Tannochside,	*	—	*
New Orbiston.—Summerlee Iron Co., Ltd.,	On South Calder, Bellshill,	*	*	*
Newton — Jas. Dunlop & Co., Ltd.,	On Light Burn, Newton,	*	*	—

Name of Work and Owner	Situation, Drainage Outfall	Means of Lessening Pollution.—Where in operation indicated by an asterisk		
		Water [illegible]	[illegible] Tanks	[illegible]
North Motherwell.—Merry & Cuninghame, Ltd.,	On Clyde, near Motherwell.	*	*	*
Parkhead.—Wilsons & Clyde Coal Co., Ltd.,	On Clyde, near Bellshill.	*	*	*
Polkemmit.—United Collieries, Ltd. (situated in Linlithgowshire),	On How Burn, Harthill.	*	—	*
Priory.—Wm. Baird & Co., Ltd.,	On Clyde, Blantyre.	*	*	*
Quarter.—United Collieries, Ltd.,	On Low Quarter Burn, Quarter,	*	*	*
Rosehall.—Robert Addie & Sons, Ltd.,	On North Calder, near Bellshill,	*	*	*
Ross.—Thos. Barr's Trust,	On Clyde, Ferniegair.	—	—	*
Royal George.—Coltness Iron Co., Ltd.,	On Auchter Water, near Newmains,	*	—	*
Shawfield.—Wilsons & Clyde Coal Co., Ltd.,	On Garrion Burn, Law Junction,	*	*	*
Shotts Iron Works.—Shotts Iron Co., Ltd.,	On South Calder, Shotts,	*	—	*
Stane.—Kepplehill Collieries, Ltd.,	On Blind Burn, Shotts,	*	*	*
Swinhill.—Darngavil Coal Co., Ltd.,	On Mill Burn, near Larkhall,	*	*	*
Southrigg.—United Collieries, Ltd.,	On How Burn, Harthill,	*	—	*
Tannochside.—Archd. Russell, Ltd.,	On North Calder Tannochside,	*	*	*
Viewpark.—Robert Addie & Son, Ltd.,	On Pow Burn, Uddingston,	*	*	*
Westrigg.—United Collieries, Ltd.,	On Barbauchlaw Burn, Westcraigs,	*	*	*
Wilsontown.—Wm. Dixon, Ltd.,	On Mouse, Wilsontown,	*	*	*

MANUFACTURING.

3.—Ammonia Works.

Name.	Situation.	Means of Preventing Pollution.
Coal-gas Works.		
Airdrie Burgh,	On South Burn,	None. Connected to sewer.
Coatbridge Burgh,	On North Burn,	Evaporation on hot coke.
Hamilton Burgh,	On Cadzow Burn,	Do. do.
Motherwell Burgh,	On South Calder,	Do. do.
Wishaw Burgh,	On Clyde,	None. Connected to sewer.
Uddingston and Bothwell,	On Myers Burn, in Drainage District,	Evaporation on hot coke.
Gas-liquor Works.		
Coatbridge.—The Gas Residual Products Co., Ltd.,	On South Burn, Coatbridge Burgh,	None.
Carfin,	On Shirrel Burn, Carfin Drainage District,	Disused mine.
Shettleston,	On Tollcross Burn, Shettleston,	Do. do.
Blast-furnace Iron Works.		
Calder.—Wm. Dixon, Ltd.,	On North Calder, Coatbridge Burgh,	Disused mine.
Gartsherrie.—William Baird & Co., Ltd.,	On Monkland Canal and Gartsherrie Burn, Coatbridge Burgh,	Do. do.
Langloan.—Langloan Iron and Chemical Co., Ltd.,	On Luggie Burn, Coatbridge Burgh,	Do. do.
Summerlee.—Summerlee Iron Co., Ltd..	On Monkland Canal and Gartsherrie Burn, Coatbridge Burgh.	Do. do.
Wishaw.—Glasgow Iron and Steel Co., Ltd.,	On Whinney Burn, Wishaw Burgh,	Evaporation in steam boilers.
Carnbroe.—Merry & Cuninghame, Ltd.	On North Calder, Carnbroe,	Do. do. do.
Clyde.—James Dunlop & Co., Ltd.,	On Clyde, Tollcross,	Evaporation in special plant and steam boilers.
Coltness.—Coltness Iron Co., Ltd.	On Auchter Water, Newmains,	Cooling and reusing; evaporation; and disused mine.

Name.	Situation.	Means of Preventing Pollution.
Shotts. — Shotts Iron Co., Ltd.,	On South Calder, Shotts,	Evaporation in steam boilers.
Shale-oil Works.		
Tarbrax. — Tarbrax Oil Co., Ltd.,	On Greenfield Burn and North Medwyn, Tarbrax,	Evaporation on hot spent shale.
Coke Ovens.		
Bedlay.—Wm. Baird & Co., Ltd.,	On tributary of Luggie Water, near Glenboig,	Disused mine
Wilsontown.—William Dixon, Ltd.	On Mouse, Wilsontown,	Do. do.
Gas Producers.		
Mossend.—Wm. Beardmore & Co., Ltd.,	On Shirrel Burn,	Under consideration
	4.—Paper Mills.	
Caldercruix. — Robert Craig & Sons, Ltd.,	On North Calder, Caldercruix,	Caustic recovery plant. Settling ponds for paper effluent. Supernatant liquid sometimes very highly coloured.
Clyde.—Clyde Paper Co., Ltd.,	On Clyde, Rutherglen Drainage District,	Caustic recovery plant. Suspended matter in paper effluent partly recovered. Additional preventive measures being provided, and effluent to be admitted to sewer.
Eastfield. — Stewart Bros.,	On Clyde, Rutherglen Drainage District,	None. Under consideration for admission to sewer.
Moffat.—Robert Craig & Sons, Ltd.,	On North Calder, Clarkston,	Special plant for recovery of suspended matter, and settling ponds. Supernatant liquid sometimes very highly coloured.

5.—Printing, Dyeing, Bleaching, and Finishing Works.

Name of Work and Owner.	Situation.	Means of Preventing Pollution.
Calico Printing.		
Glengowan.—John Glen & Sons,	On North Calder, Caldercruix,	Precipitation by lime and sulphate of alumina; settling ponds, large area.
Turkey Red Dyeing.		
Cambuslang. — T. P. Miller & Co.,	On Clyde, Cambuslang,	In Rutherglen Drainage Area, and liable for Glasgow Purification Assessment.
Bleaching and Dyeing.		
Avonbank. — D. C. Miller & Co., Ltd.,	On Avon, Larkhall,	Precipitation tanks and settling pond.
Govanroft. — W. Manson & Sons,	On Tollcross Burn, Tollcross,	Connection to sewer—Glasgow Dalmarnock Sewage Works.
Hogganfield.—Hogganfield Bleach and Finishing Co., Ltd.,	On Molendinar Burn, Hogganfield, within Barony Drainage District,	Do. do. do.
Bleaching and Finishing.		
Carmyle.—James Park & Co ,	On Clyde, Carmyle,	No polluting effluent.
Clydebank. — Andrew Robertson & Son, Ltd.,	On Clyde, within Rutherglen Drainage District,	To be connected to outfall sewer, Glasgow South-side Sewage Scheme.
	6.—Chemical Works.	
Shawfield. — J. & J. White,	On Clyde, within Rutherglen Burgh,	To be connected to outfall sewer, Glasgow South-side Sewage Scheme.
Tannoch.—Shand Bros.	On Luggie Water, near Cumbernauld,	Settling pond and ash filters.
	7.—Distilleries.	
Malt.		
Clydesdale. — Clydesdale Distillery Co., Ltd.,	On Clyde, Wishaw Burgh,	Connection to sewer and irrigation fields.
Grain and Yeast.		
Gartloch.—J. Calder & Co., Ltd.,	On Bathlin Burn, Garnkirk,	Settling tanks and ponds and connection to Barony Drainage District sewer and Glasgow Dalmarnock Sewage Works.

III.—SEWAGE POLLUTIONS.

The term sewage does not imply that the pollutions under this heading do not contain trade refuse, but that their prevailing character is that of domestic or household liquid refuse. The chief sources of sewage pollution are the large towns and populous places, the drainage from which is under the control of Local Authorities.

The actual occurrence and the degree of pollution will depend mainly upon (1) the size of the community; (2) the means adopted to purify the sewage; and (3) the flow of water in the stream affected. Information on the first two points will be found in the table and the text which follow. The sources of pollution are numbered on the map placed in front, and by referring to the corresponding number in the table and in the text the information indicated can be obtained.

The construction of sewage purification works has either been undertaken or is receiving serious consideration by most Local Authorities. It is desirable, therefore, that accurate information should be available as to the results that have so far been attained. With that object in view, sampling has been carried out and analyses made by the staff dealing with rivers pollution. This has involved a considerable amount of labour and expense, but the details of all the results obtained have been at once made available to the Local Authorities and their officials. In this report the more important analytical data will be found in Appendix I. It will be found that none of the streams dealt with as liable to pollution by sewage are utilised as sources of public water supply. Some of them, however, are largely used for trade purposes and the watering of cattle.

TABLE SHOWING THE DRAINAGE DISTRICTS, BURGH AND COUNTY (ARRANGED IN TOPICAL ORDER), THE STREAMS AFFECTED, AND THE MEANS ADOPTED TO PREVENT POLLUTION, ETC.

DRAINAGE DISTRICTS.				STREAMS AFFECTED.	MEANS OF PREVENTING POLLUTION—Where in operation indicated by an Asterisk. PURIFICATION WORKS.			
						Filters.		
Nos.	Burgh and County.	Area.	Population.	Situation of Drainage Outfall.	Tank.	Contact	Continuous.	Irrigation.
		Acres.						
1	Biggar Burgh,	62	1,400	Biggar Burn and Biggar Water (2 Outfalls),	*	—	—	*
2	Thankerton,	150	280	Glade Burn,	—	—	—	*
3	Carnwath,	110	918	Carnwath Burn,	*	—	*	—
4	Douglas,	197	1,400	Douglas Water (2 Outfalls)	*	—	—	—
5	Crosslaw,	513	340	Ponclair Burn,	—	—	—	*
6	Lanark Burgh,	506	5,746	Clyde,	*	—	*	—
7	Lesmahagow,	261	2,100	Nethan (3 Outfalls),	—	—	—	—
8	Carluke,	470	5,200	Jock's Burn (Several Outfalls),	—	—	—	*
9	Law,	2,180	1,800	Garrion Burn (Several Outfalls),	—	—	—	*
10	Wishaw Burgh,	919	23,048	South Calder and Clyde (2 Outfalls),	—	—	—	*
11	Dalziel and Netherton,	395	1,540	Clyde,	*	—	—	*
12	Strathaven,	250	4,685	Powmillon Burn,	*	*	—	*
13	Stonehouse,	103	3,500	Cander Water and Avon,	—	—	—	—
14	Larkhall,	559	13,200	Avon and Clyde,	—	—	—	—†
15	Motherwell Burgh—							
	Coursington,	1,324	35,136	South Calder,	*	—	*	—
	South Side,			Clyde (3 Outfalls),	—	—	—	—†
16	Hamilton Burgh—							
	West End,	1,332	38,950	Clyde,	*	*	—	—
	East End,			Cadzow Burn and Clyde,	—	—	—	—†
17	Cleland and Omoa,	64	2,100	Tillon Burn,	*	*	—	—
18	Bothwell,	318	2,200	Clyde (Several Outfalls),	—	—	—	—
	Fallside,	64	1,200	Pow Burn,	*	Tracks		—
19	Blantyre—East,	502	13,000	Clyde,	—	—		—†
	Springwells,	19	795	Park Burn,	*	—	*	—
20	Aitkenhead and Tannochside,	85	3,805	Clyde,	—	—	—	—

† Ground acquired, and in some cases outfall sewers constructed.

DRAINAGE DISTRICTS.				STREAMS AFFECTED.	Means of Preventing Pollution—Where in operation indicated by an Asterisk. Purification Works.			
						Filters.		
Nos.	Burgh and County.	Area.	Population.	Situation of Drainage Outfall.	Tank.	Contact.	Continuous.	Irrigation.
		Acres.						
21	Uddingston,	374	8,700	Clyde,	•	—	—	—
22	Chapelhall—East,	13	1,000	Shotts Burn,	•	—	•	—
	West,	32	1,000	North Calder,	—	—	—	—
23	Carfin,	59	1,740	Shirrel Burn,	—	—	—	•
24	New Stevenston,	68	3,120	Shirrel Burn,	—	—	—	—
25	Holytown,	30	2,000	Shirrel Burn,	—	—	—	—
26	Bellshill and Mossend,	518	13,000	Shirrel Burn,	—	—	—	—†
27	Airdrie Burgh,	1,049	25,000	North and South Burns,	—	—	—	—
28	Coatbridge Burgh,	1,845	43,710	North and South Burns and Luggie Burn,	—	—	—	—
29	Baillieston,	220	3,750	North Calder (2 Outfalls),	—	—	—	—†
30	Mount Vernon (Carmyle),	752	4,150	North Calder and Clyde,	—	—	—	—†
31	Newton and Flemington,	178	4,700	Light Burn,	•	—	—	—
32	Cambuslang,	668	18,300	Clyde (3 Outfalls),	—	—	—	—
33	Shettleston and Tollcross,	837	14,600	Clyde,	—	—	—	—†
34	Stepps,	251	1,200	Garnkirk Burn,	•	—	•	—
35	Lenzie,	379	1,200	Kelvin,	•	—	—	•
36	Kirkintilloch Burgh,	841	11,000	Kelvin,	—	—	—	•
37	Bishopbriggs,	637	3,000	Bishopbriggs Burn,	•	—	—	—
38	Busby,	103	567	White Cart,	•	•	—	—
39	East Kilbride,	108	1,930	Kittoch Water,	•	•	—	—
40	Carmunnock,	94	480	Kittoch Water,	—	—	—	—

† Ground acquired, and in some cases outfall sewers constructed.

The foregoing table briefly indicates the methods of sewage purification adopted, but detailed notes will now be given regarding each area. Illustrations of some of the sewage works and streams are also given.

No. 1.—Biggar Burgh (Area, 62 acres; Population, 1,400).—There are two sewer outfalls, which convey the sewage not only from all houses within the burgh, but also from several houses immediately outside the burgh, situated on the Station Road. These outfalls discharge into small, open, settling tanks, the effluent from which is irrigated on suitable land, and then drains to the Biggar Burn and Biggar Water, which joins the River Tweed.

The west-end outfall conveys about three-fourths of the sewage. It also receives an overflow from the water supply service tank, but arrangements will be provided for excluding this overflow water when desired, such, for example, as during the night when the flow is considerable. All the road surface water also enters the sewerage system, and it will be desirable to have a storm overflow at the works to lessen the volume of sewage to be dealt with during heavy rainfall. For the purification of this sewage the Commissioners acquired early in the year 1900 an area of nearly $8\frac{1}{2}$ acres of land, extending along the left bank of Biggar Burn. Two settling tanks were at first provided, but a third has been added. They each measure 21 feet by 9 feet by 4 feet, and have a total capacity of about 14,000 gallons, and each is fitted with a scum board at the outlet. The sewage is irrigated on the land during the whole year.

At the east-end outfall the sewage is settled in two tanks, each measuring 15 feet by 8 feet by 4 feet, and having a total capacity of 6,000 gallons. The effluent is irrigated for about nine months of the year upon meadow land on Heavyside Estate. When this land is being cropped the sewage is diverted on to about $3\frac{1}{2}$ acres adjoining.

The tanks are cleaned out frequently on to the surface adjoining, and when the sludge has solidified it is carted away for manurial purposes.

The works have been frequently inspected, and sampling of the sewage and effluent has been carried out from time to time, especially at the west end. The last sampling took place on 9th June last, and extended over a period of ten hours—6.15 a.m. to 4 p.m. There was no rainfall during the time of sampling, and there had been none for two days previously. The average hourly flow of sewage was about 6,000 gallons. The analytical results show that the strength of the sewage gradually increased up to about 3 p.m., and that the amount of purification effected was from 70 to 80 per cent.

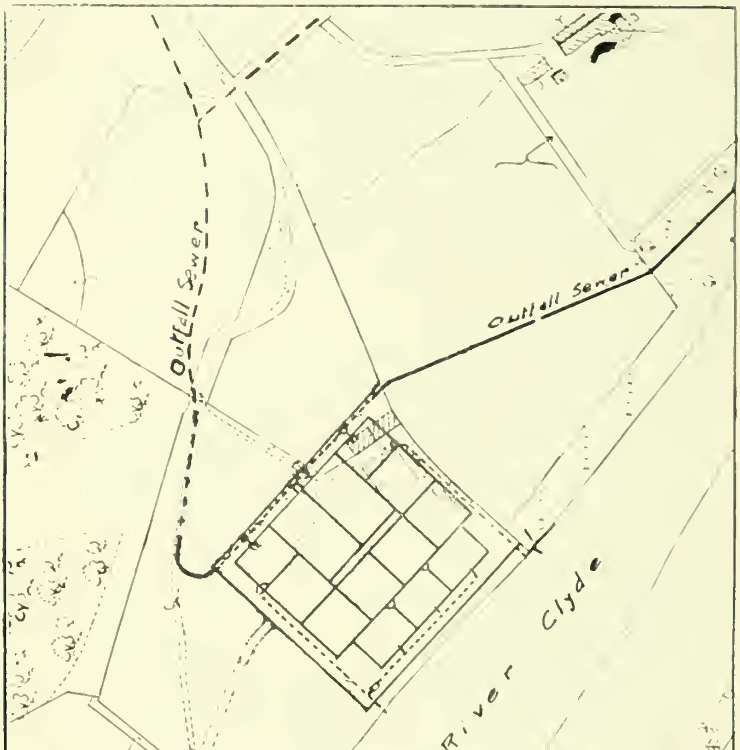
No. 2.—THANKERTON (Area, 150 acres; Population, 280).—This special drainage district was formed in 1902. The sewage is conveyed by one outfall underneath the railway to about 3 acres of land situated to the east of Thankerton Mill. This land drains into the Glade Burn, which joins the Clyde.

No. 3.—CARNWATH (Area, 110 acres; Population, 918).—This special drainage district was formed in 1902, but the sewerage and sewage purification works were not completed until June, 1906. When all the old drains have been connected up, the whole of the sewage will be conveyed to one outfall at the purification works situated on the right bank of Carnwath Burn. These works, as presently constructed, consist of a covered septic tank and one continuous filter. The tank is 35 feet by 13 feet by 5 feet, having a capacity of about 14,000 gallons. Before entering the tank the sewage passes through a grit chamber, 6 feet by 4 feet by 4 feet. The filter consists of clinker, held by open stone walls on a concrete base. The size of the material is about 3 inches, and is not graded. The filter is 3 feet deep, and the dimensions give about 60 cubic yards. The distribution is by wooden channels on to twenty-four Stoddart trays. The tank has not yet been cleaned out, although it is known to contain a large quantity of sludge. At times a considerable quantity of suspended material has come over with the tank effluent, and interfered with the proper working of the filter. It has been suggested that the outfall sewer should be extended further down the stream to a field near Lampits Farm, where it could be irrigated, and the drainage would quickly join the River Clyde. Owing to complaints made by a farmer whose fields are watered by Carnwath Burn, numerous inspections have been made and samples taken for analyses.

No. 4.—DOUGLAS (Area, 197 acres; Population, 1,400).—This special drainage district was formed in 1891. The sewage from it is conveyed by two outfalls into the Douglas Water. Two intercepting cesspool tanks are provided, one on each outfall, to prevent solid sewage matter entering the stream. Owing to these tanks being somewhat small, defective in construction, and not cleaned out regularly, pollution occurs.

No. 5.—CROSSLAW (Area, 513 acres; Population, 340).—This special drainage district was formed in 1893. In 1908 a portion of

BURGH OF LANARK SEWAGE WORKS.



the district was included within the Burgh of Lanark. The sewage, however, is still conveyed to farm lands adjoining the Ponclair Burn, which joins the Clyde.

No. 6.—Lanark Burgh (Area, 506 acres; Population, 5,746).—There are two sewer outfalls, which convey the sewage from the whole burgh to purification works situated on the right bank of the River Clyde, near Kirkfieldbank. The works were completed in 1905, and discharge the effluent into the River Clyde. They comprise two covered tanks, 6 primary filters, 3 secondary filters, and 2 storm-water filters. The tanks each measure 90 feet by 53 feet by 7 feet, having a total capacity of 420,000 gallons, which equals 28 hours' dry-weather flow. In each tank there are three baffle walls built up from the floor to about 1 foot above top water level. The inlet pipes to the tanks dip about 1 foot 8 inches below water level. Provision is made for collecting the deposit in the tanks in a sludge well by means of perforated pipes laid along the floor of the tanks. From this well the sludge is removed by gravitation. At the inlet end of the tanks is a grit chamber, and a detritus trap is also placed on each sewer. At the outlet end are two measuring chambers, which receive the tank effluent, each having a capacity of about 7,000 gallons. With a normal flow they take about an hour to fill and about fifteen minutes to discharge. This discharge is controlled by mechanical apparatus, which send it to each of the six primary filters in turn.

The walls of the filters are built of concrete, and the filtering material consists of clinker, the size of which ranges from 2 inches to ½ inch. The six primary filters are each 54 feet by 54 feet by 3 feet 6 inches deep, giving 2,268 cubic yards; the three secondary filters are each 54 feet by 45 feet by 3 feet deep giving 810 cubic yards. The total cubic contents of both series of filters amount to 3,078 cubic yards. Stated in relation to the volume of sewage, there is one cubic yard of filter material to 137 gallons daily dry-weather flow. The two storm-water filters are each 58 feet by 45 feet. The distribution is by slotted fireclay pipes laid near the surface. After passing through the primary filters, the effluent passes to one of the three secondary filters. With a normal flow, the six primary filters receive about twenty fillings of tank effluent in twelve hours, or fully three fillings in twelve hours for each filter, with approximately three hours rest between each filling. The filters can also be put into contact by operating a penstock valve, but as this involves manual labour, the contact system has not been employed. The storm-water filters have not been used.

The septic tanks have not been cleaned out. The measuring chambers have been cleaned out once, about a year ago.

In August, 1905, soon after the works came into operation, average samples were taken and analysed, the average purification effected being found to be about 84 per cent.

On 7th July of this year a fifteen-minute average sampling of crude sewage, tank effluent, and filter effluent was also carried out, commencing at 7.30 a.m., and ending at 7.15 p.m. During this sampling there were three periods of rainfall. Thus, it rained heavily from 7.45 to 9.15 a.m.; it was showery from 10.30 to 11.15, and from about 4 o'clock it rained heavily until 5 o'clock. Measurements of the flow were taken. These show that the dry-weather flow was at the rate of about 15,000 gallons an hour, but the flow through the works rose for a short time to about 40,000 gallons per hour, exclusive of what escaped by the storm overflows direct to the river.

The analytical results show that the strength of the sewage was greatest between 11 a.m. and 2 p.m., and that the amount of purification effected was 50 per cent. All the samples showed a considerable quantity of suspended matter.

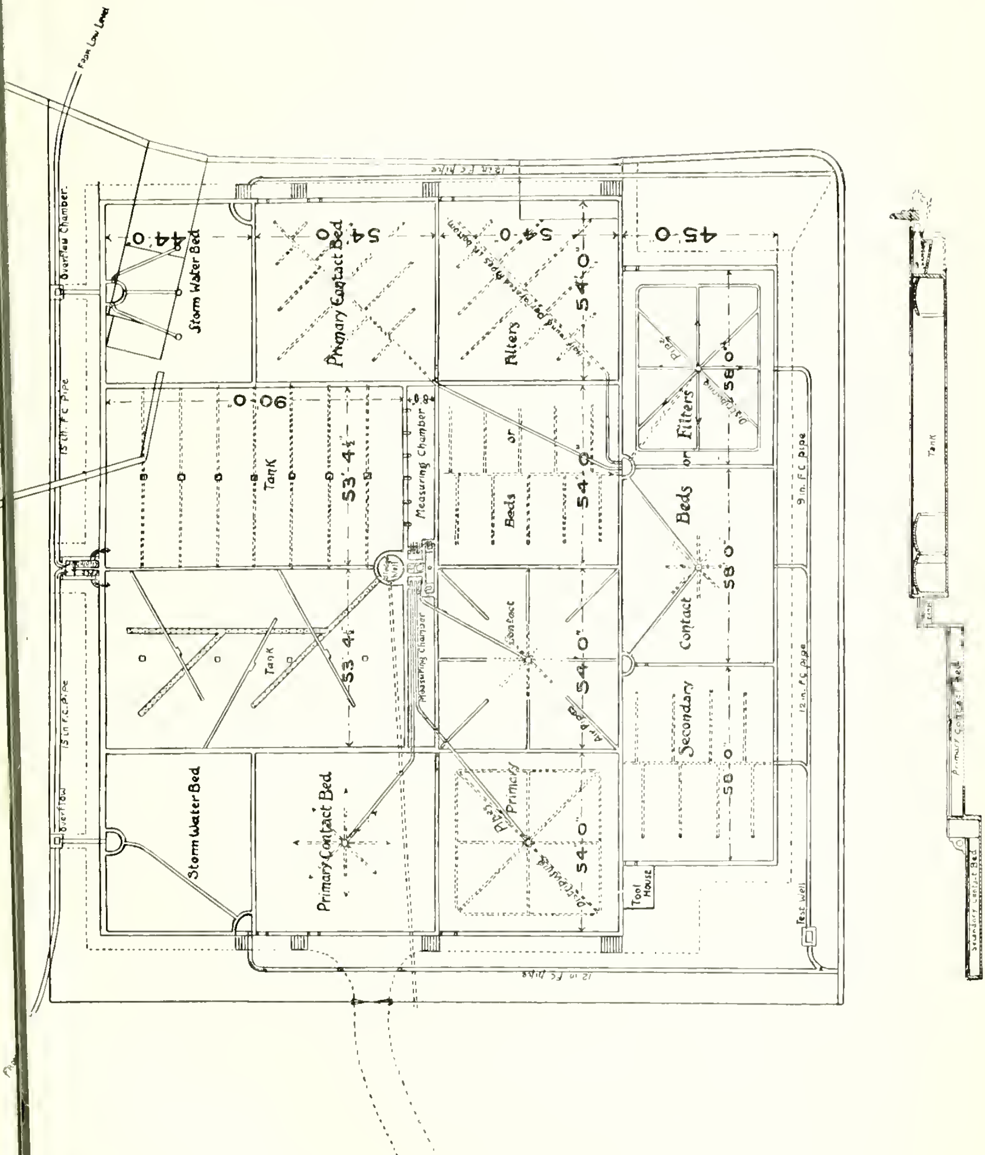
No. 7.—Lesmahagow (Area, 261 acres; Population, 2,100).—This special drainage district was formed in 1891. The sewage is conveyed to the River Nethan by three main outfalls. No purification works have yet been provided, but the effect upon the stream is not serious. The provision of tanks, at least, is desirable.

No. 8.—Carluke (Area, 470 acres; Population, 5,200).—This special drainage district was formed in 1891. There are altogether nine outfalls from this district, which mostly drain to Jock's Burn, which joins the Clyde. The main outfall discharges on to about 20 acres of land to the west of the Caledonian Railway Station. The sewage from two other outfalls on the north of the district is conveyed to land at Castlehill and Whiteshaw, where it is irrigated. Six outfalls convey sewage direct to Jock's Burn. These outfalls are at present being dealt with by the local committee, and an irrigation scheme has been suggested.

No 9.—Law (Area, 2,180 acres;* Population, 1,800).—This district was formed in 1894. A considerable portion of the sewage is conveyed to and irrigated on farm lands. Recently it was agreed to extend one of the outfalls underneath the Caledonian Railway on to

* Co-extensive with water district, but only the populous part provided with sewers.

BURGH OF "LANARK" SEWAGE WORKS.



James Murray, C.E.

the side of the Garrion Burn, where ground has been acquired, on which it is intended to erect purification works.

No. 10.—WISHAW BURGH (Area, 919 acres; Population, 23,048).—There are two main sewer outfalls from this burgh. One is situated at Cambusnethan, which conveys a small portion of sewage to a small burn which joins the South Calder without purification; the other outfall, which was reconstructed in 1905 at considerable cost, conveys the remainder of the sewage to the farm lands of Carbarns, about two miles from Wishaw, on the right bank of the Clyde, where irrigation has been carried on for upwards of forty-eight years. The farm is leased by the Commissioners from Lord Belhaven until 1913, together with a large field on the estate of Cambusnethan. At the present time serious pollution affecting the Clyde occurs, and the results of analyses show that trade liquid refuse interferes with the purification of the sewage. In the vicinity of the lands the outfall sewer is provided with regulating chambers, from which the sewage is directed to various fields for irrigation. The greater portion is carried to the fields around the farm steading, and, after irrigation, it is caught up by agricultural drains and open channels connected with main drains, which enter a large settling area. This area is subdivided by transverse embankments with openings, which convey the sewage to the outfall. Four filter tracks, measuring 150 feet by 2 feet by 2 feet, are also provided, but these are not usually in operation.

The area of the lands used for irrigation extends to about 160 acres, or about 7 acres per 1,000 population.

In 1903 the Commissioners obtained a Provisional Order for acquiring land and the construction of purification works, which are under consideration.

No. 11.—DALZIEL AND NETHERTON (Area, 395 acres; Population, 1,540).—This special drainage district was formed in 1901. A portion of the area was included within the Burgh of Motherwell by an extension of the burgh boundaries in 1908. The sewage is conveyed to purification works which were designed for the requirements of the original area. The works, which were completed in 1904, are situated at Low Muirhouse, and consist of a covered tank and 20 acres of irrigation land, which drain to the River Clyde. The tank is 72 feet by 16 feet by 6 feet 6 inches, having a capacity of 46,800 gallons, which gives fully 24 hours' estimated dry-weather flow. In 1907, 85 cubic yards of sludge were cleaned out of the tank, and again, in May of the present year, 107 cubic yards.

No. 12.—STRATHAVEN (Area, 250 acres; Population, 4,685).—This special drainage district was formed in 1887. The whole of the sewage is conveyed to purification works situated on the left bank of the Powmillon Burn. About 80 per cent. of the road surface water of this drainage area is admitted to the sewers. The works, which were completed in August, 1903, consist of two covered tanks and ten contact filters. The tanks measure 100 feet by 15 feet by 6 feet 6 inches and 100 feet by 11 feet by 6 feet 6 inches respectively, giving a total capacity of 105,600 gallons, equal to about 8 hours' dry-weather flow. Grit chambers are provided at the inlet end of the tanks. The filters consist of clinker, the bottom of which is drained by perforated fireclay pipes. The size of the material is graded from 1½-inch to ¼-inch. Each filter is 3 feet 9 inches deep, and the contents amount to 1,800 cubic yards, which gives one cubic yard of filtering material to about 180 gallons daily dry-weather flow.

The distribution is by wooden troughs. The filling and emptying of the filters is controlled by Adams' syphonic gear. Each filter is filled in 50 minutes, stands full for 30 minutes, discharges in 50 minutes, and rests 70 minutes.

The tanks were cleaned out on two occasions, viz.:—In 1905, when 180 cubic yards of sludge were removed, and in 1907, when 170 cubic yards of sludge were removed.

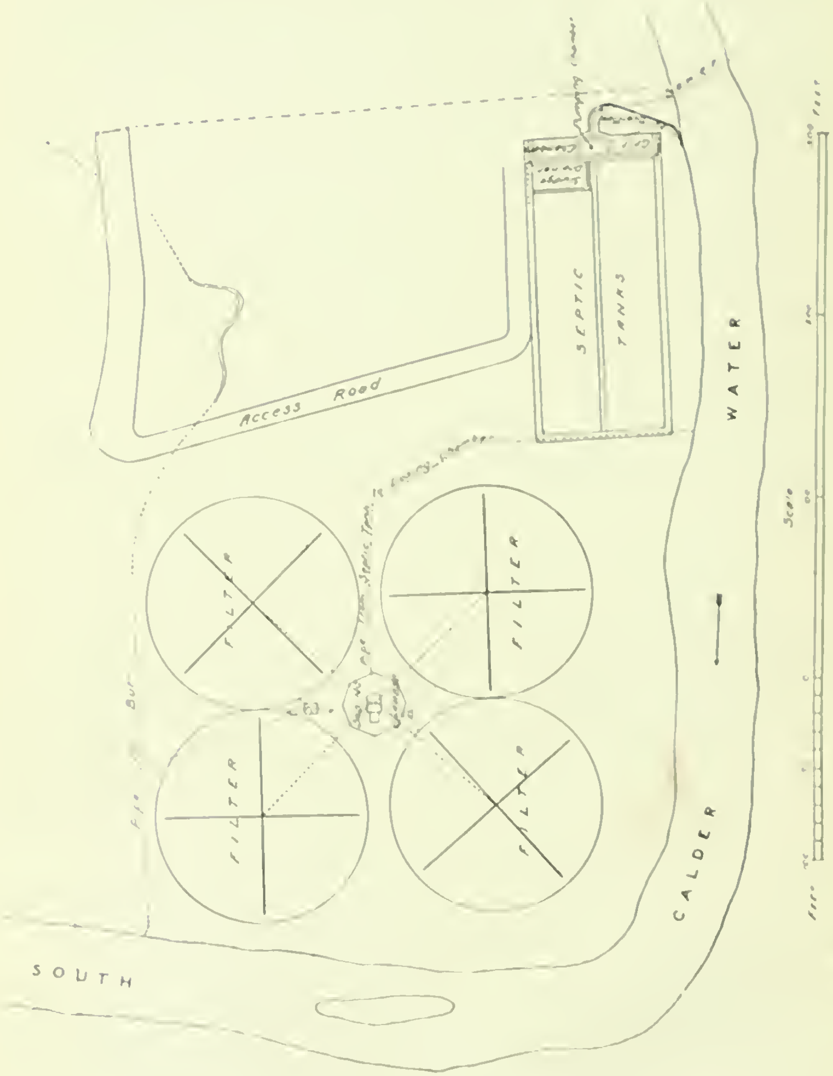
Storm overflows are provided at the works.

A special average sampling took place on 17th August last, over a period of twelve hours, from 8 a.m. to 8 p.m. The dry-weather flow of sewage, as measured, was 18,484 gallons per hour. Of this quantity, 12,825 gallons per hour were conveyed to the filters, and the remainder to a small irrigation meadow. The maximum flow was 25,718 gallons between 4 and 5 p.m. This large flow was due to washings discharged from the mechanical water filters owned by the Middle Ward District Committee, and situated at Redleeshill.

The analytical results show that the sewage was strongest between 12 noon and 4 p.m., and that the average amount of purification effected was 51 per cent.

No. 13.—STONEHOUSE (Area, 103 acres; Population, 3,500).—This special drainage district was formed in 1898. The main outfall is to the Cander Water, which joins the Avon. No purification works have yet been provided, but the Drainage Committee are at present carrying on negotiations for ground on which to erect works.

BURGH OF MOTHERWELL COURSINGTON SEWAGE WORKS.



W. A. Carter, C.E.

No. 14.—LARKHALL (Area, 559 acres; Population, 13,200).—This district was formed in 1892. There are three outfalls, two to the River Avon and one to the River Clyde. Until recently the sewage draining to the Avon was irrigated. This system of purification has been abandoned, and land has been acquired for the construction of works. These works, which will consist of septic tanks and filters, will be situated respectively at Braehead and High Merryton, and will deal with the sewage from rather more than half of the district. No special means of purification have yet been adopted for the sewage outfall to the River Clyde.

No. 15.—MOTHERWELL BURGH (Area, 1,324 acres; Population, 35,136).—The sewage from this burgh is conveyed, on the north side of the town to the South Calder, and on the south side by three outfall streams to the River Clyde. Purification works dealing with almost the whole of the sewage on the north side have been provided. They are situated on the right bank of the South Calder at Coursington, and were completed and brought into operation in 1908. The area draining to them is 550 acres, and the population 12,000, or about one-third of the total population of the burgh.

The works consist of two covered tanks, one dosing chamber, and four continuous filters. The tanks are each 150 feet by 32 feet by 13 feet, having a total capacity of 548,000 gallons, which is equal to twenty-four hours' dry-weather flow. At the inlet end of the tanks are two grit chambers, each 20 feet by 10 feet by 10 feet, and a pump well, 10 feet by 10 feet by 15 feet. The sludge in the tanks and the grit chambers can be discharged into the pump well, but only that from the grit chambers is frequently removed. At the outlet end of the tanks is a baffle chamber, from which the sewage passes into the dosing chamber. This chamber is octagonal in shape, measures 32 feet inside, and is situated in the centre of the four filters. It is provided with a self-acting syphon, which discharges continuously to the filters.

The filters are circular in shape, and the material is steel slag held by open slag walls on a concrete floor, which has a declivity from the centre to the outlet channel. The size of the filter material is graded from above downwards, as follows:—

FILTER MATERIAL.

Depth.	Size.
12 inches	$\frac{3}{8}$ths.
6 „	1 inch.
3 feet.	2 to 4 inches.
9 inches.	Rough slag, say, 9 inches.

The average depth of the filters is 5 feet and their diameter 120 feet, giving a total cubic area of 7,867 cubic yards, which allows one cubic yard of material to 74 gallons per day of dry-weather flow.

The distribution is by Adams' Patent "Cresset" Revolving Sprinklers, controlled by head of water from the dosing chamber. All four filters, or any number of them, can be worked at one time, there being check valves on the outlet pipes into which the syphon discharges. The rate of flow on to the filters depends upon the variations in the head of water.

A special average sampling took place on 20th April last over a period of twelve hours, from 8 a.m. to 8 p.m. There was no rainfall during the time of sampling. The dry-weather flow was therefore measured, and found to be about 24,000 gallons per hour. The analytical results show that the strength of the sewage was greatest between 1 and 2 p.m., and that the amount of purification effected was on an average 73 per cent.

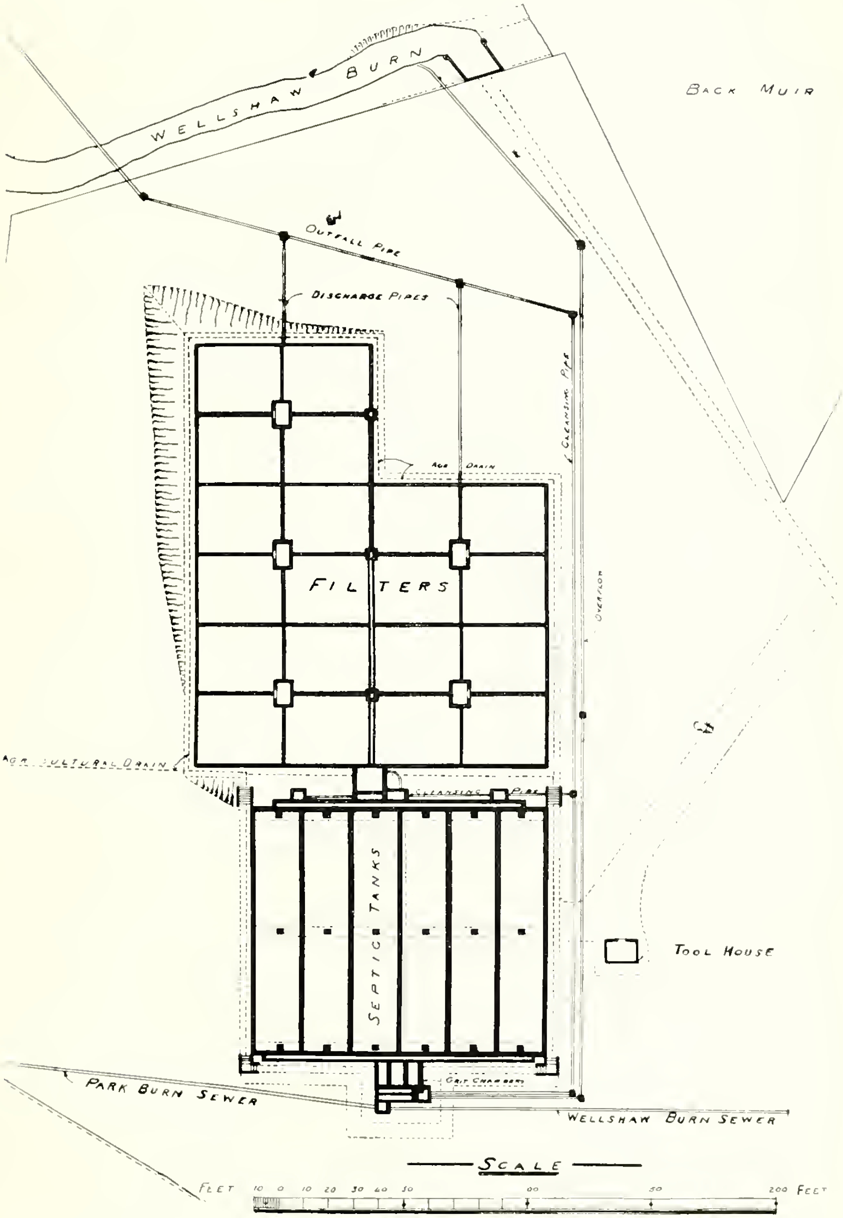
The analyses also show that samples taken between 11 and 12 noon contained trade effluent, which comes from the sulphate of ammonia plant of the Burgh Gas-works.

The purification works were at first worked for some time on trial, during which it was found that the drainage of a large steel work was silting up the tanks. Both tanks were therefore cleaned out, when about 179 cubic yards of wet sludge were removed. This sludge contained a considerable amount of steel dust. Preventive measures were subsequently provided at the steel works.

Purification works for the sewage from the south side of the burgh are to be provided shortly.

No. 16.—Hamilton (Area, 1,332 acres; Population, 38,950).—The sewage from this burgh drains by two main outfalls to the River Clyde. The upper or east-end outfall is by the Cadzow Burn, without purification, and the lower or west-end outfall is by a sewer discharging at the Park Burn below Bothwell Bridge. The latter outfall conveys the sewage effluent from the purification works which deal with the sewage from the west-end of the burgh, including Greenfield and Burnbank. The Greenfield sewer conveys pit water from Greenfield Colliery, as well as other liquid trade refuse. The works were completed in 1906, and are situated on ground immediately adjoining the public park. They have been designed to serve a population of 15,000. The works consist of 6 covered tanks and 20 contact filters, arranged in five sets of four each. The tanks each measure 98 feet 6 inches by 18 feet by 7 feet, having a capacity of 463,050 gallons, or fully 14 hours' dry-

BURGH OF HAMILTON—PARK BURN SEWAGE WORKS.



Wylie & Blake C.E

weather flow. At the inlet end of the tanks there are three grit chambers, each 10 feet by 5 feet by 3 feet. From these chambers a feeding channel leads off to the septic tanks, any one of which can be shut off when desired. Slotted cast-iron pipes, laid horizontally across the width of the tanks, deliver the tank effluent into the main channel leading to the filters.

The filters consist of steel slag, broken to gauge and freed from dust, and they are drained by agricultural drain pipes. The filters are each 34 feet by 27 feet by 6 feet deep, giving a total cubic content of 4,080 cubic yards, which equals one cubic yard of filtering material to 178 gallons daily dry-weather flow. The distribution is by stoneware channels, and is controlled by automatic gearing of the Septic Tank Company's central basin type. This apparatus distributes the effluent over each filter in turn, allowing regular periods for filling, remaining in contact, discharging, and resting.

A special average sampling took place on 23rd March last, extending over a period of twelve hours from 8 a.m. to 8 p.m. There was no rainfall on the day of sampling, and the dry-weather flow as measured was 377,570 gallons, or an average hourly flow of 31,458 gallons. The analytical results show that the strength of the sewage gradually increased till 1 p.m., and that the purification effected was 70 per cent.

The question of providing a suitable site for works to deal with the sewage discharging to the Clyde by the Cadzow Burn is, after long negotiation, nearing solution—a probable site for purification works being at Smithycroft, on the ducal estate and to the south-east of the burgh.

No. 17. — Cleland and Omoa (Area, 64 acres; Population, 2,100).—This special drainage district was formed in 1900. The sewage from it is conveyed to purification works situated on the Tillon Burn, a tributary of the South Calder. The works, which were completed in 1902, consist of a covered tank and 5 contact filters. The tank measures 53 feet by 15 feet by 6 feet 6 inches, having a capacity of 32,250 gallons, equal to twelve hours' dry-weather flow. A small grit chamber is provided at the inlet end of the tank, and at the outlet end there is a settling well.

The filters consist of clinker, and are drained by perforated fire-clay pipes. The size of the material ranges from 2½ inches to ½ inch; the bottom 12-inch is broken to pass through a 2½-inch ring, and be retained on 1½-inch ring; the remainder is broken to pass through a 1¼-inch mesh, and be retained on ½-inch mesh. The filters are 3 feet 9 inches deep, and the contents amount to 320 cubic yards,

which equals one cubic yard of filter material to 200 gallons daily dry-weather flow. The distribution is by wooden troughs, and is controlled by Adams' patent syphonic gear.

In 1905 a special 9-hours' sampling took place, and the analytical results showed that the purification then effected amounted, on an average, to 82 per cent. Since that occasion, alterations have been made in the tank, which is now sub-divided near the outlet by a wall built up from the floor to within 3 inches of the water level. There are also two baffle boards to arrest black humus which discharges with the tank effluent. The filter material at first consisted of engine ashes, but these were replaced by destructor clinker a year ago.

The tank was cleaned out on two occasions—in 1906, when 73 cubic yards of sludge were removed, and again in 1908, when 66 cubic yards were removed.

No. 18.—Bothwell (Area, 382 acres; Population, 3,400).—This district was formed in 1868, and was enlarged in 1899. There are altogether five outfalls. One of these is connected with the Uddingston District outfall, which discharges through a septic tank to the Clyde at Haughhead Bridge. Another outfall conveys a portion of the sewage to purification works on the Pow Burn at Fallside. The other three outfalls discharge directly into the River Clyde, but the quantity of sewage from these is not great. The purification works at Fallside deal with an area of 64 acres, and the population, estimated at 1,200, includes a large institution—Kirklands Asylum. The sewage works were completed in 1904, and consist of a covered tank and filter tracks. The tank measures 53 feet by 15 feet by 6 feet 3 inches, having a capacity of 31,450 gallons, equal to 19 hours' dry-weather flow. There is a grit chamber at the inlet end of the tank, and settling well at outlet. The tank effluent is irrigated on winding clinker tracks, in which the size of the clinker ranges from 3 inches to 8 inches.

Average samples of crude sewage, tank effluent, and filter track effluent were taken in September, 1905, when the average purification effected, comparing the crude sewage with the filter effluent, amounted to about 52 per cent. In June, 1906, further average samples were taken, in two series, to determine what extent of purification the filter tracks accomplished. Comparing the tank effluent with the filter effluent, the purification effected was found to amount to about 18 per cent.

No. 19.—Blantyre (Area, 521 acres; Population, 13,795).—This special drainage district was formed in 1875, was enlarged in 1898, and again in 1900. For the purposes of sewage purifica-

tion the district has two drainage areas—one large area on the west side, which drains to the Clyde; and a small area on the east side—Springwells—the outfall of which is to the Park Burn. For the former area the outlet sewer has been laid to a site at the Old Blantyre Mills, where ground has been acquired on which works will be erected. The Springwells area is drained to works of that name, situated on the Park Burn. The area drained is 19 acres, and the population 795. The works were completed in 1906, and consist of a grit chamber, covered tank, and two continuous filters. The tank measures 25 feet by 12 feet by 8 feet, and has a capacity of 15,200 gallons, equal to about eight hours' dry-weather flow, and is provided with a large shallow outlet well, of 5,000 gallons capacity, which is fitted with scum walls for intercepting flocculent matter and humus discharged from the tank.

The filters consist of clinker, broken to pass through a 3-inch ring and to be retained on a 2-inch ring. They are 4 feet deep, with open sides, a surface area of 90 square yards, and a total content of 110 cubic yards, which equals 1 cubic yard of filtering material to 455 gallons daily dry-weather flow. The effluent from the tank is distributed over the filters by means of Stoddart trays. It should be mentioned that the sewage flow is considerably augmented by a discharge from an aerated water works, and also by a large amount of surface and subsoil water coming from drains connected to the old sewerage system. To prevent solids (sulphate of lime) entering the drain from the aerated water works, a settling tank was constructed by the firm, and requires frequent cleaning out. The septic tank was emptied in 1906, when about 28 cubic yards of sludge were removed; again in 1908, when about 30 cubic yards were removed; and also in the present year, when about 40 cubic yards of sludge were removed. The works are looked after by the drainage attendant, who attends to the sewerage system in the whole Blantyre Drainage District. Average samples of crude sewage tank effluent and filter effluent were taken and analysed in February, and again in April, 1906, when the average purification effected was found to amount on each occasion to 69 per cent. A special average sampling was also carried out on 25th and 26th March, 1907. This sampling was continued over a period of twenty-four hours, from 9 p.m. on 25th to 9 p.m. on 26th. There was no rainfall, and the average dry-weather flow of sewage was 2,260 gallons per hour.

The character of the sewage varied greatly from hour to hour

during the day; but from midnight to 6 a.m. the sewage strength scarcely varied, and was uniformly weak. Special attention is directed to the fact that from 7 p.m. to 7 a.m. the quality of the tank effluent was very much stronger than that of the crude sewage. The analytical results show that the amount of purification effected was 56 per cent.

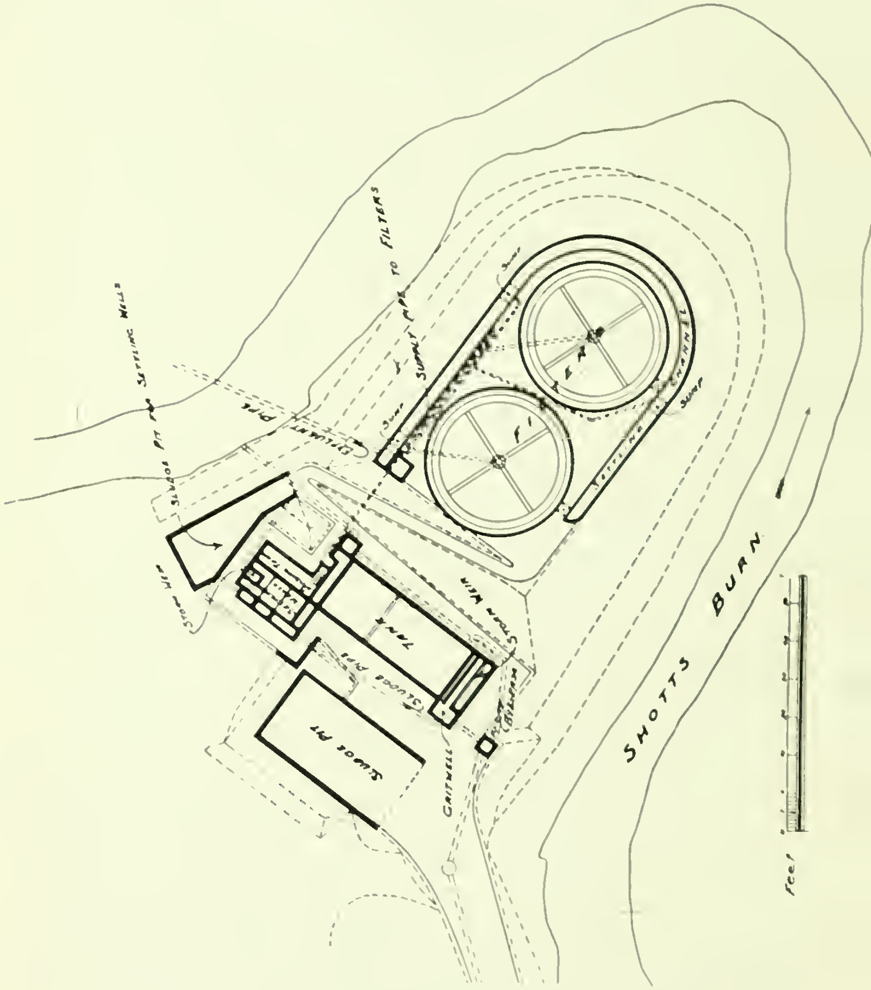
No. 20.—Aitkenhead and Tannochside (Area, 85 acres; Population, 3,805).—This special drainage district was formed in 1898. The whole of the sewage is connected to the main outfall sewer for the Uddingston Special Drainage District, which discharges to the River Clyde near Haughhead.

No. 21.—Uddingston (Area, 374 acres; Population, 8,700).—This special drainage district was formed as far back as 1868, extended in 1897, and again in 1901. The sewage is conveyed by two outfalls to the Clyde. The main outfall sewer also conveys the whole sewage from Aitkenhead and Tannochside District, as well as sewage from a small portion of Bothwell District. This outfall discharges into the Clyde near Haughhead Bridge, below Uddingston. Formerly a portion of the sewage conveyed by this outfall from Uddingston and Bothwell was discharged into the Pow Burn, where works, which were brought into operation in 1899, are situated. These were the first sewage purification works provided by the Middle Ward District Committee. Recently they have been abandoned, with the exception of the tank. This has been brought about by the large increase of sewage flow to the works compared with the period in which they were erected. It is intended that new works will be erected in the vicinity of the outfall at Haughhead Bridge. For a description of the old works reference may be made to the First Report on Rivers Pollution Prevention, issued in 1903. There it will be found that the tank which is still in operation measures 80 feet by 20 feet by 5 feet 6 inches at the inlet end, 4 feet 6 inches at the outlet end, and its capacity 47,600 gallons, which is equal to about six hours of the present dry-weather flow.

On four occasions sludge has been cleaned out of the tank. The amount of sludge removed on each occasion was as follows:—In May, 1902, 150 cubic yards; December, 1903, 160 cubic yards; in January, 1906, 220 cubic yards; and in September, 1907, 150 cubic yards.

A special sampling was carried out on the 27th and 28th February, 1907. On this occasion the filters were in operation, and average hourly samples over a period of twenty-four hours of crude sewage, tank effluent, and filter effluent were taken. The character of

MIDDLE WARD DISTRICT—CHAPELHALL SEWAGE WORKS.



W. L. Douglass,
District Engineer.

the sewage during the day was found to be three times stronger than that of the night. It was also found that the greater portion of the solids present in the sewage was retained in the tank. The analytical result showed that the average percentage of purification effected by the filters during the night was 36 per cent., and during the day 54 per cent.

No. 22.—Chapelhall (Area, 45 acres; Population, 2,000).—This special drainage district was formed prior to 1890. The sewage is discharged by two outfalls—one on the west side to the North Calder, and one on the east to the Shotts Burn, a tributary of the North Calder. Purification works for the western outfall are under consideration. For the eastern outfall, which drains an area of 13 acres and a population of 1,000, purification works are in course of completion. These comprise a tank, settling chamber, dosing tank, and two continuous filters. The tank is 40 feet by 15 feet by 7 feet, with a capacity of 26,250 or twenty-four hours' estimated dry-weather flow. At the inlet end of the tank a grit chamber is provided. The settling chamber at the outlet end has a capacity of 1,475 gallons, and is intended to intercept flocculent matter. From the settling chamber the effluent will pass into the dosing tank which controls the flow to the filters. Provision is made for passing the tank effluent direct to the dosing tank.

The filters are circular, and consist of clinker, drained at the bottom by perforated drainage tiles. The size of the material ranges from 6 inches to $1\frac{1}{2}$ inches. The bottom 6 inches is broken to pass a 6-inch ring and be retained on a 4-inch ring; the top 4 inches is broken to pass through a 2-inch ring and be retained on a $1\frac{1}{2}$-inch ring; and the remainder is broken to pass a 3-inch ring and be retained on 2 inches. The depth of the filters is 5 feet, and the dimensions give a cubic contents of 350 cubic yards, which equals 1 cubic yard of filter material to 61 gallons daily dry-weather flow. Should the filters be worked alternately, then the rate of flow per cubic yard of filtering material would be 150 gallons per day.

The distribution is by Adams' rotary or revolving sprinklers, controlled by head of water. The channel receiving the filter effluent is provided with sumps to intercept suspended matter.

Sludge pits or wells are also provided, into which the various tanks can be cleaned out.

No. 23.—Carfin (Area, 59 acres; Population, 1,740).—This district was formed in 1905, since which a portion of the area, known as Cleekhimin, was included within the extension of the Burgh of Motherwell in 1907. There are two outfalls—one from houses on the south side of the district, which discharges into the South Calder; and one on the north side, discharging to the Shirrel Burn. For the sewage from the south side, arrangement has been made with the Burgh of Motherwell for receiving it into their sewers and purifying it at their purification works at Coursington. The sewage from the northmost part of the district (that is Carfin) is conveyed to land near Hattonhill, where it is irrigated. The land extends to one and a-half acres, and drains to the Shirrel Burn. A grit tank is provided, and measurements have been taken of the actual flow of sewage. A septic tank is at present being designed by the District Engineer. Within the district there is a gas-liquor work, but the trade effluent from it is disposed of in a disused mine.

No. 24.—New Stevenston (Area, 68 acres; Population, 3,120).—This district was formed in 1899. The sewage is conveyed direct to the Shirrel Burn without purification.

No. 25.—Holytown (Area, 30 acres; Population, 2,000).—This district was formed in 1898, and is adjacent to New Stevenston. There is one outfall, which discharges into the Shirrel Burn opposite the outfall from New Stevenston. Purification works have not yet been provided.

No. 26.—Bellshill and Mossend (Area, 518 acres; Population, 13,000).—This district was formed in 1878, and extended in 1908 so as to include Mossend and Milnwood. For the purpose of sewage purification the district has two drainage areas—one on the north side, which drains to the Shirrel Burn and North Calder; and one on the south side, which drains to the South Calder. Land has been acquired on which to erect purification works for the north area, which will deal with rather more than half the sewage of the whole district.

No. 27.—Airdrie Burgh (Area, 1,049 acres; Population, 25,000).—This burgh was formed in 1821, and extended in 1885. The sewage of the whole burgh is conveyed, without purification, into the North Burn, the South Burn, and the Brown Burn. Most of the houses on the north side of the town drain to the North

VIEWS SHOWING EFFECT OF POLLUTION OF STREAMS BELOW AIRDRIE AND COATBRIDGE

At the confluence of the Luggie and North Calder Waters.
The water is in a state of fermentation, and the surface is covered with bubbles.

North Calder Water at Dam, Bredisholm Forge.
Looking up the stream the surface of the water is still affected.

Burn, but the greater number of houses drain to the South Burn, which flows through the centre of the town, where it is for some distance enclosed in a culvert. All three streams are grossly polluted by sewage as they pass into or by the territory of the county. The pollution of these streams was brought before the burgh as far back as 1896, and since then a great number of inspections have been made of the streams, and samples taken for analyses over a considerable period. In 1905 legal proceedings were instituted against the Burgh Authorities, who, in their statement of facts, contended that at the point where said burns and streams enter the territorial jurisdiction of the county they are not polluted by any solid or liquid sewage. After the case had been decided in the Sheriff Court in favour of the County Council, without going to proof, on an appeal by special case, a proof on this point alone was allowed by the Court of Session, and the evidence was taken in the Sheriff Court in 1908. The analytical results showed that the streams polluted by the burgh contained from 30 to 111 times more unoxidised nitrogen (which may be taken as an indication of the degree of pollution) than those streams in the neighbourhood not affected by the burgh.

No. 28.—COATBRIDGE BURGH (Area, 1,845 acres; Population, 43,710).—This burgh was formed in 1885. The sewage is all conveyed, without purification, into the lower reaches of the North and the South Burns, which receive the sewage of the Burgh of Airdrie. These streams unite in the centre of Coatbridge, and become known as the Luggie Burn, which flows into the North Calder. The analytical results of the samples taken from the streams show that they contained from 33 to 110 times more unoxidised nitrogen than those streams in the neighbourhood of the burgh. Legal proceedings were also instituted in 1905 against the burgh by separate action at the same time as the proceedings against the Burgh of Airdrie.

No. 29.—BAILLIESTON (Area, 220 acres; Population, 3,750).—This district was formed prior to 1890. There are two outfalls (one on the west side, and the other on the east), which convey the sewage to the North Calder, without purification. Land has, however, been acquired on which to erect works to treat the sewage from both outfalls. For the western outfall plans have been prepared for a new sewer and purification works, but the construction of these has been postponed owing to the certainty of subsidence of the ground from mineral workings in the near future.

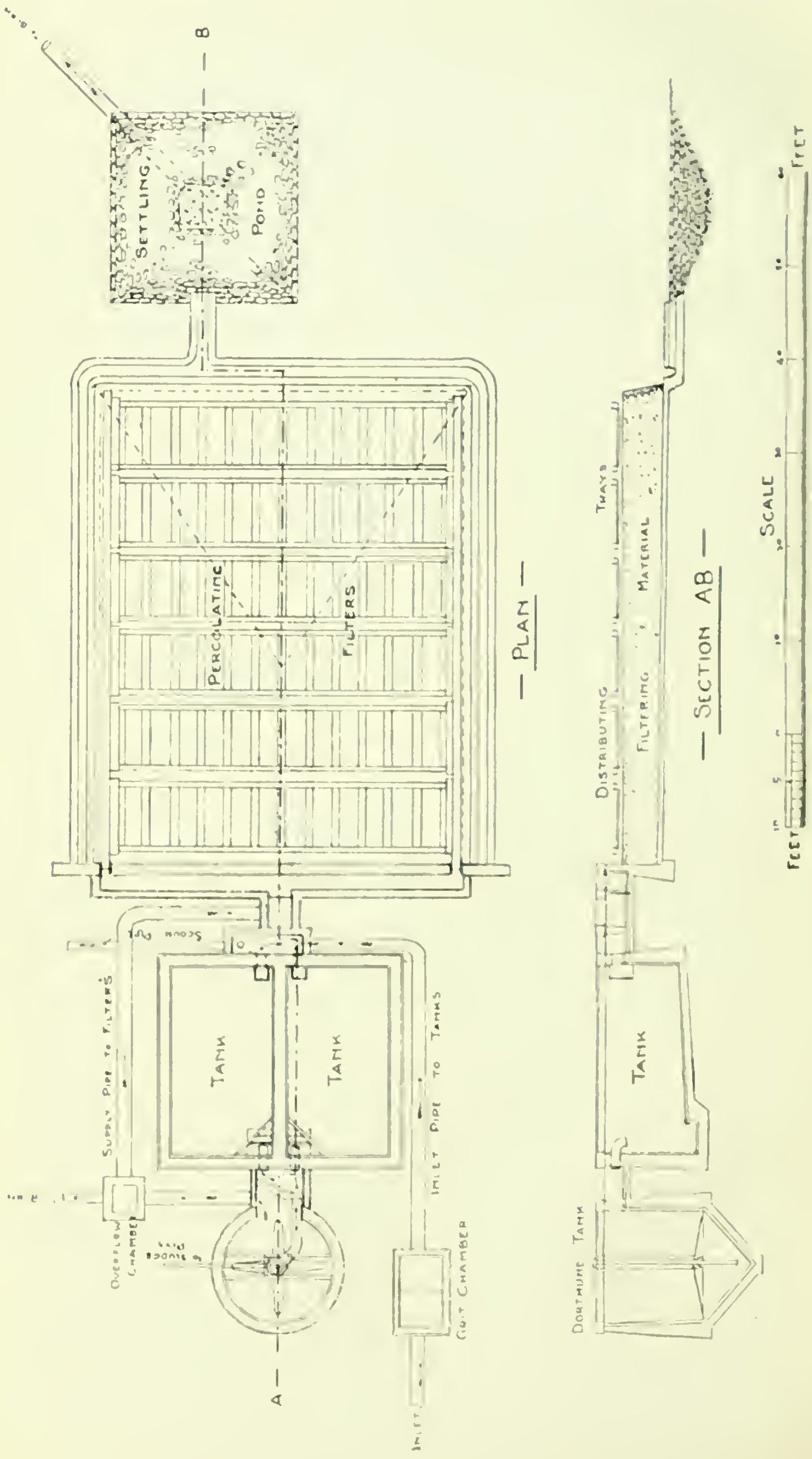
No. 30.—Mount Vernon (Area, 752 acres; Population, 4,150).—This district was formed in 1893. The sewage is conveyed by several outfalls—one goes direct to the River Clyde at Carmyle, one to the Battles Burn at Tollcross, and another to the North Calder at Broomhouse. The sewage conveyed by the outfall at Carmyle is to be dealt with in tanks and filters to be constructed on land at Kenmure. The outfall to the Battles Burn is to be dealt with in sewage purification works to be provided by the Lower Ward District Committee at Westthorn for their Tollcross area. The outfall to the North Calder has not yet been provided for.

No. 31.—Newton and Flemington (Area, 178 acres; Population, 4,700).—The district was formed in 1901. The sewage is conveyed to the site of the purification works, where it is passed through two covered tanks which discharge into the Light Burn. These tanks were constructed in 1905, and measure respectively 95 feet by 14 feet 6 inches by 7 feet 9 inches and 95 feet by 12 feet by 7 feet 9 inches, having a combined capacity of 114,000 gallons, which equals two and a-half days' dry-weather flow. Both tanks were cleaned out in 1907, when 211 cubic yards of sludge were removed.

No. 32.—Cambuslang (Area, 668 acres; Population, 18,300).—This district was formed in 1895, and extended in 1906. The sewage is conveyed by three outfalls direct to the River Clyde, but the two upper of these, which deal with about four-fifths of the total sewage, will be connected up, and will discharge at a point above Gateside Burn. The purification of the sewage from this outfall has been the subject of much inquiry, consideration, and report. At one time it was contemplated that the sewage might be connected with the Glasgow South-Side Scheme, but it was found that it would be less costly to have it dealt with in a local scheme. This scheme provides for the construction of tanks and filters on lands at Threenenk, the outfall sewer being conveyed across the valley of the burn on piers to the site mentioned. For the lower outfall nothing definite has yet been arranged, but it is understood that a suitable site can be acquired for the purpose of erecting purification works.

No. 33.—Shettleston and Tollcross (Area, 837 acres; Population, 14,600).—This area is the southern portion of the Barony Drainage District, which is not connected with the

LOWER WARD DISTRICT—STEPPS SEWAGE WORKS.



rren & Stuart, C.E.

Glasgow Corporation sewerage system. It includes that portion of Shettleston and Tollcross in the Lower Ward which drains to the Tollcross Burn Sewer Outfall and to the Battles Burn. The whole sewage of the area is therefore conveyed to the River Clyde without purification. Three schemes, however, have been under consideration by the Local Authority for the district—

(1) Disposal at Dalmarnock Sewage Works, with sewer extension *via* London Road;

(2) Disposal at Dalmarnock Sewage Works, with sewer extension *via* Dalbeth and Easterhill; and

(3) Disposal at proposed works at Westthorn.

The relative cost of all three schemes were submitted by the Engineers for the Lower Ward Local Authority, who have since decided on the third scheme, viz., disposal at proposed purification works at Westthorn. The works will comprise septic tanks and filters. The dry-weather flow of sewage is 671,600 gallons per day. The estimated cost of the works alone is £16,063.

No. 34.—Stepps (Area, 251 acres; Population, 1,200).—This district was formed in 1906. The sewage is conveyed to the outfall at purification works which discharge into the Garnkirk Burn. These works were completed and brought into operation in 1908. They consist of two open septic tanks, a Dortmund tank, and a continuous filter. The septic tanks each measure 20 feet by 11 feet by 6 feet 6 inches, and have a capacity of 17,874 gallons, which equals 8 hours' dry-weather flow. The Dortmund tank, which receives the tank effluent, is 12 feet diameter and 14 feet deep, having a capacity of 7,544 gallons. This tank is specially adapted for retaining the finer solids, which can be removed from time to time by a draw-off sludge pipe which feeds from the bottom of the tank.

From this tank the effluent passes to the filter, which consists of clinker drained by agricultural tiles into the outlet channel. The filtering material is of large size, laid on concrete, and is held by walls of clinker. The depth of the filter is 3 feet 6 inches; the capacity is 220 cubic yards, which gives 1 cubic yard of filtering material to 243 gallons daily dry-weather flow. The distribution is by 72 tray distributors. For intercepting particles in suspension in the filtrate an effluent well is provided, and has a capacity of 3,750 gallons. A sludge pit is also provided.

A special average sampling was carried out on 18th February, and again on the 3rd August. The dry-weather flow, as measured, was about 2,230 gallons per hour. Between the dates of the

sampling all the tanks were cleaned out, and special attention is drawn to the fact that the analytical results show that the suspended solids of the tank effluent on 3rd August amount to only 4·6 parts per 100,000, while the purification effected by the tanks alone amounted to 31 per cent.

No. 35.—Lenzie (Area, 379 acres; Population, 1,200).—This district was formed prior to 1890. All the sewage is, by arrangement, purified with that from the Burgh of Kirkintilloch on suitable land at Dryfield, known as Dryfield Sewage Farm, within the county area, and which drains into the River Kelvin.

No. 36.—Kirkintilloch Burgh (Area, 841 acres; Population, 11,000).—This burgh is situated in the County of Dumbarton. The sewage is, however, conveyed to land within the County of Lanark at Dryfield, known as Dryfield Sewage Farm, which was acquired by the Commissioners in 1886. The land comprises 10 acres, and is laid out in 13 plots on which crops of vegetables and oats are cultivated.

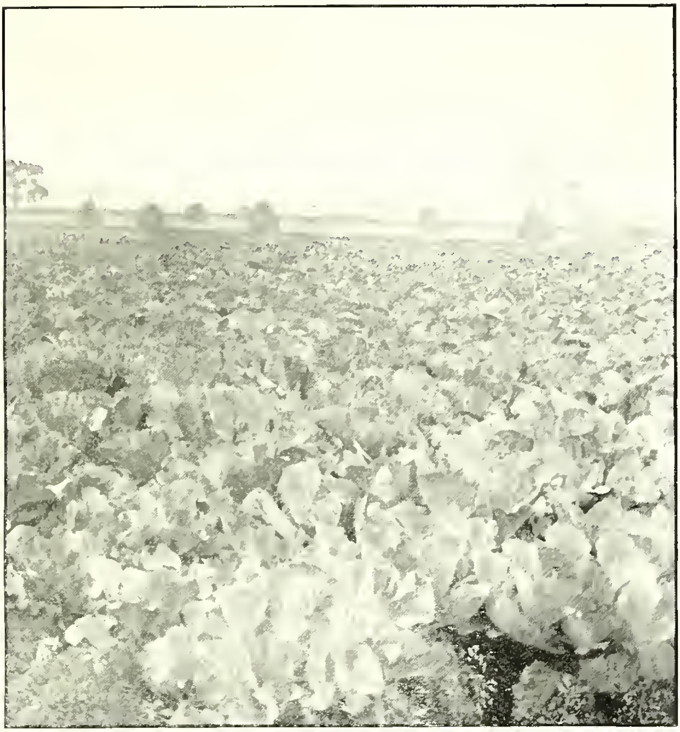
The sewage is received at the farm by two outfalls—one from the town itself, and the other from the district of Lenzie. The town sewage is discharged into a large circular tank, from which it is pumped into the irrigation plots at stated periods of the day. That from Lenzie is led into open tanks, and gravitates on to the irrigation plots. The irrigation is downward through sand to a depth of from 6 feet to 9 feet. All the tanks are cleaned out regularly, the sludge being disposed of on the farm land.

Analyses of samples taken on two occasions showed that about 85 per cent. of purification is obtained. Intermittent pollutions have been found taking place, due to sewage passing direct from the collecting well to the Kelvin. Pollution also occurs during the night, when pumping operations are suspended.

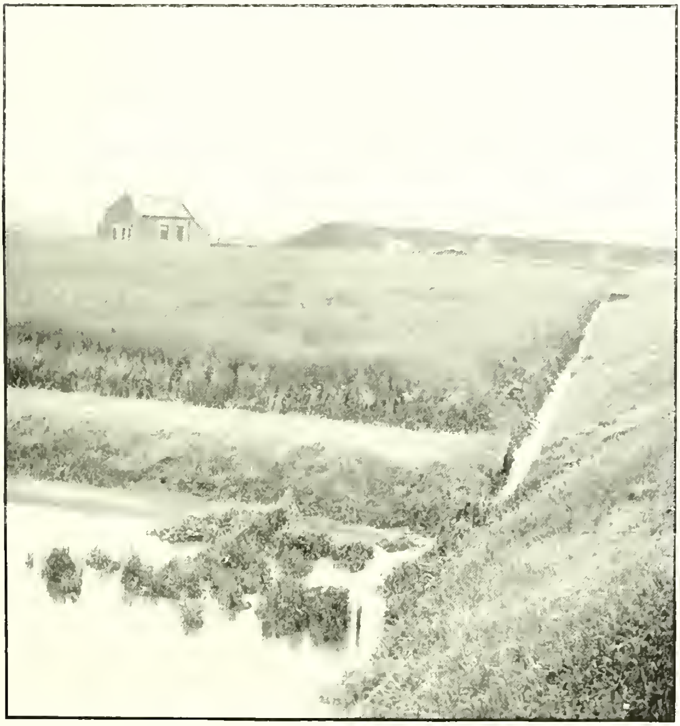
The works are attended by a man who devotes his whole time to the treatment of the sewage.

No. 37.—Bishopbriggs (Area, 637 acres; Population, 3,000).—This special drainage district was formed in 1905. The sewage is conveyed by a main outfall sewer, which enters purification works situated at Kenmure, on the Bishopbriggs Burn, into which the effluent discharges. The works consist of two tanks, provided with grit chambers and sludge pits. Each tank measures 48 feet by 14 feet 3 inches by 7 feet 6 inches, and combined have a total capacity of 59,660 gallons, or 13 hours' dry-

BURGH OF KIRKINTILLOCH—SEWAGE IRRIGATION FIELDS IN CROP.

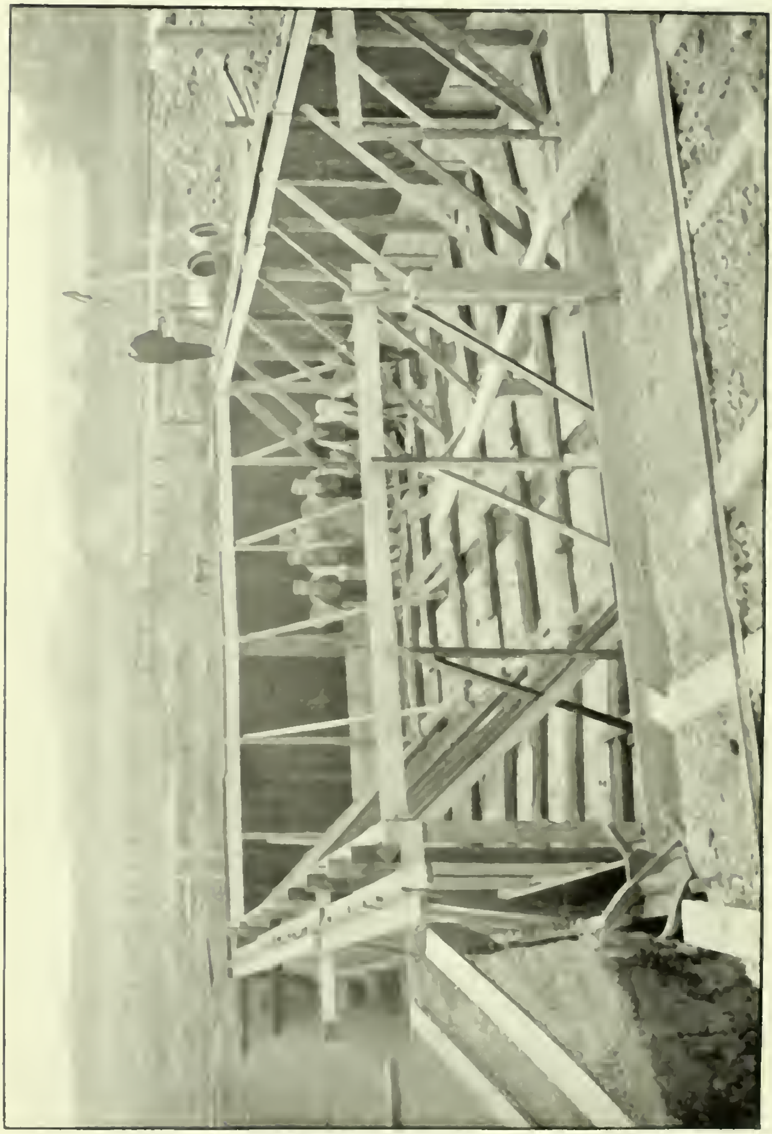


Cabbages, with Hay in distance.



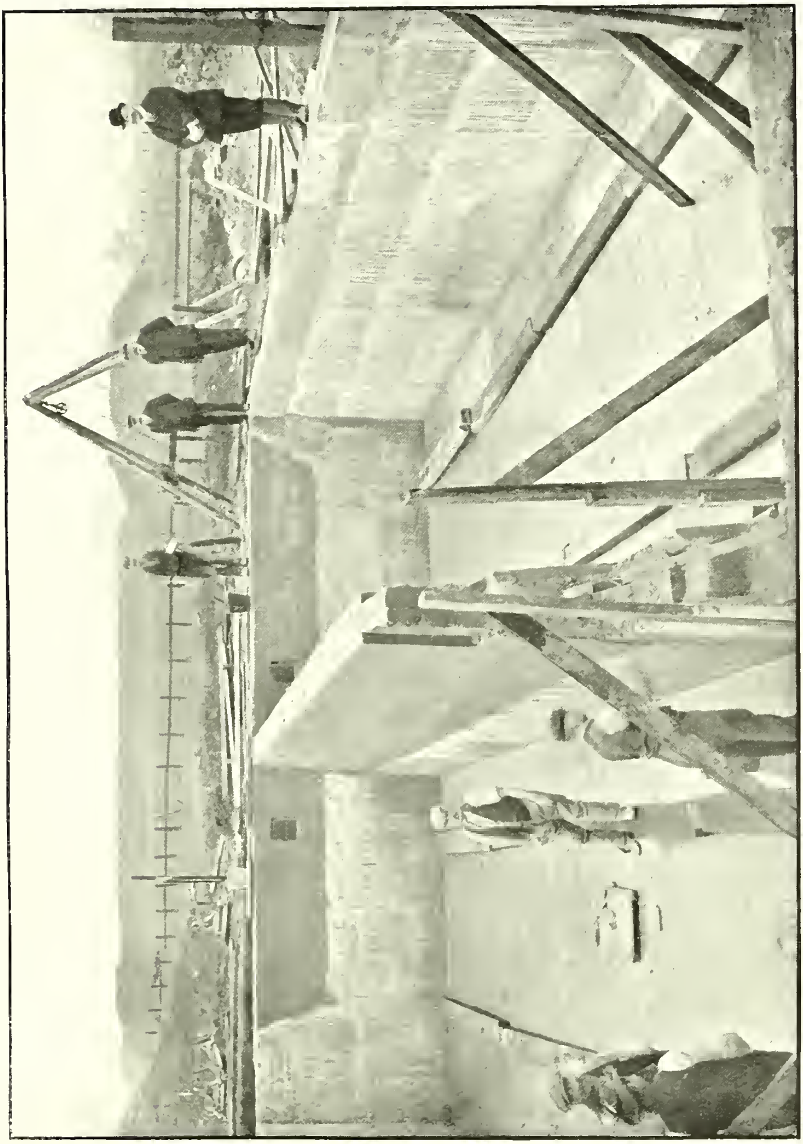
Oats, with Pumping Station in distance.

LOWER WARD DISTRICT—BISHOPBRIGGS SEWAGE WORKS.



Timbering for Concrete Work of Tanks.

LOWER WARD DISTRICT—BISHOPBRIGGS SEWAGE WORKS.



Tanks in course of construction.

LOWER WARD DISTRICT—BISHOPBRIGGS SEWAGE WORKS.

Open Tanks showing Sludge on Surface

weather flow. A separator, 13 feet in diameter and 10 feet in depth over all, with a capacity of 4,905 gallons, similar in design to the Dortmund Tank at Stepps Sewage Purification Works, is to be placed to receive the tank effluent, and filters are now being provided. They will measure from 2 feet to 2 feet 6 inches in depth, and have a capacity of about 590 cubic yards, which will equal 1 cubic yard of filtering material to 193 gallons daily dry-weather flow.

No. 38.—Busby (Area, 103 acres; Population, 567).—This district was formed in 1899. The sewage is conveyed to purification works, from which it enters the White Cart. The works were completed in 1903, and comprise a covered tank and four contact filters. The tank measures 53 feet by 15 feet by 6 feet 3 inches, and has a capacity of 31,450 gallons, or 11 hours' dry-weather flow. The whole of the road surface water is admitted to the sewers, with the result that the slightest rain very considerably increases the flow. The tank is provided with a grit chamber at the inlet end and a settling chamber at the outlet end. The filters consist of clinker, and are drained by perforated fire-clay pipes. The size of the material ranges from $1\frac{1}{2}$ inches to $\frac{1}{4}$ inch. The bottom 6 inches is broken to pass through a $1\frac{1}{2}$-inch mesh and be retained on a 1-inch mesh; the remainder is broken to pass through a 1-inch mesh and be retained on a $\frac{1}{4}$-inch mesh.

The filters are each 3 feet $7\frac{1}{2}$ inches deep, with a cubic content of 381 cubic yards, which equals 1 cubic yard of filtering material to about 184 gallons daily dry-weather flow. The distribution is by wooden troughs or channels laid on the surface. The filling and emptying of the filters are controlled by Adams' syphonic gear.

The tank, which is fitted with a chain pump, was cleaned out in February, 1908, when 36 cubic yards of sludge were removed.

No. 39.—East Kilbride (Area, 108 acres; Population, 1,930).—This district was formed in 1899. The whole of the sewage is conveyed to purification works which discharge into the Kittoch Water. At first these works consisted only of a covered tank. Later two clinker tracks were provided.

In May of the current year the works were reconstructed, and now consist of the tank and five contact filters. The tank measures 60 feet by 16 feet by 5 feet, and has a capacity of 30,000 gallons, equal to about 10 hours' dry-weather flow. At the inlet

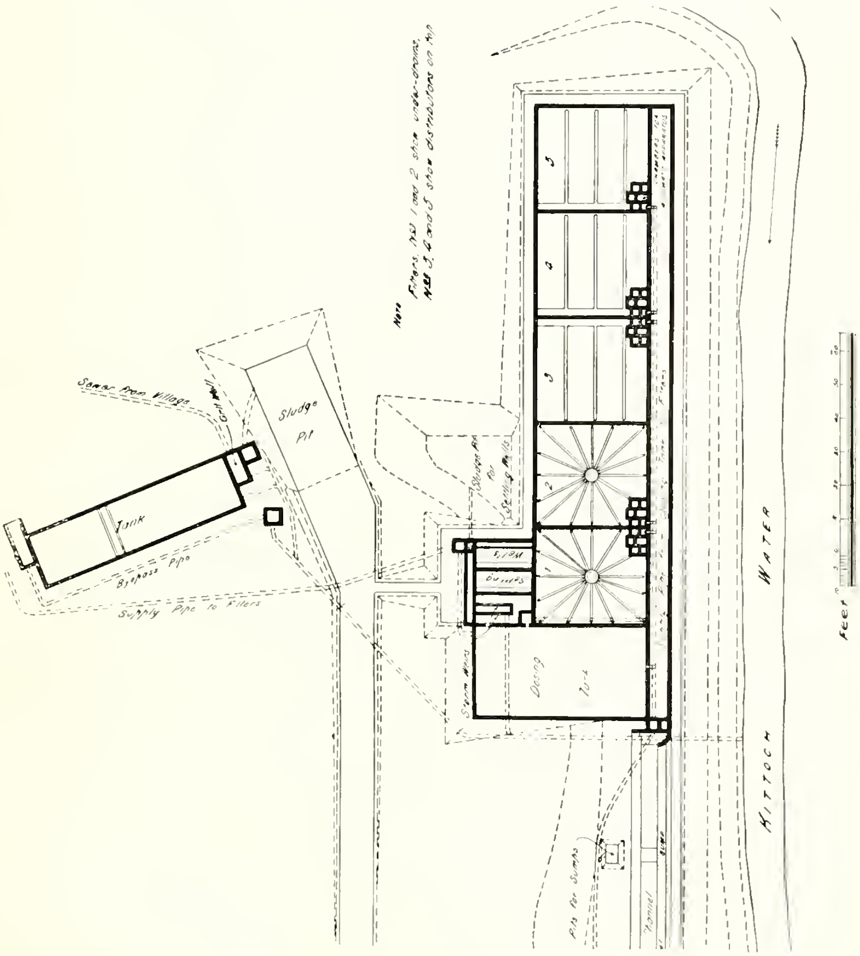
end a grit chamber is provided, and a settling well at the outlet to intercept suspended matter. There is also a regulating chamber leading to a dosing tank. An alteration was made on the tank, which consisted in putting a wooden division wall across it about 40 feet from the inlet end, with the view of confining the sludge and solid matter to one end, and allowing the black humus, which formerly escaped, to settle in the other end to a great extent. The settling wells at the outlet end have a capacity of 3,860 gallons, and are provided with two scum boards and two scum walls. Means are provided for flushing out the humus deposited into a small pit. The regulating chamber is provided with an orifice discharging into the dosing tank, and a storm overflow weir discharging into a fire-clay pipe to the Kittoch Water. The dosing tank has a capacity of 8,700 gallons, and has been provided for the purpose of equalising the rate of discharge on to the filters. The filters consist of clinker, and are drained by horse-shoe, fire-clay tiles. The size of the material ranges from $2\frac{1}{2}$ inches to $\frac{5}{8}$ inch—the bottom 9 inches is broken to pass through a $2\frac{1}{2}$-inch ring and be retained on $1\frac{1}{2}$-inch ring; the remainder is broken to pass a $1\frac{1}{8}$-inch mesh and be retained on a $\frac{5}{8}$-inch mesh. The depth of the filters is 3 feet, with a total content of 570 cubic yards, which gives 1 cubic yard of filtering material to 112 gallons daily dry-weather flow. The distribution is by wooden troughs, and is controlled by automatic apparatus, which has been so designed that each filter is filled in about 60 minutes, and, after standing full for 45 minutes, is emptied in about 15 minutes. The filter effluent passes along a broad concrete channel, with sumps in it to intercept suspended or flocculent matter. At the end of this channel there is a small water wheel for the purpose of further aerating the effluent before it passes into the outlet pipe to the burn.

The tank, since it was brought first into use, has been cleaned out on three occasions, as follows:—In August, 1905, quantity of sludge removed not known; in May, 1907, when 106 cubic yards were removed; and in April, 1909, when 50 cubic yards were removed.

Prior to the alterations and additions to these works, a large number of inspections were made and many samples taken for analyses.

A special twelve hours' average sampling was carried out on the 31st August last. The dry-weather flow, as measured, was about 3,000 gallons per hour.

MIDDLE WARD DISTRICT—EAST KILBRIDE SEWAGE WORKS.



W. L. Douglass,
District Engineer.

The analytical results show that the strength of the sewage gradually increased up till 5 p.m., and that the average purification effected was 66 per cent.

No. 40.—Carmunnock (Area, 94 acres; Population, 480).—This district was formed prior to 1890. The sewage enters the Padmure Burn without purification. This burn joins the Kittoch Water, which flows into the White Cart. Proposals to deal with the sewage of the district are under consideration.

In preparing this portion of the Report I have been indebted for information regarding sewage purification works to the following engineers:—W. L. Douglass, for the Middle Ward District schemes; Warren & Stuart, for the Lower Ward and some Upper Ward schemes; W. A. Carter for the Burgh of Motherwell scheme; and Wylie & Blake for the Burgh of Hamilton scheme; also to the Burgh of Lanark Town-Clerk and James Murray, C.E., Sanitary Inspector for the Lower Ward of Renfrewshire, for information regarding the Burgh of Lanark scheme—to all of whom my best thanks are due.

Village Communities.—Throughout the County there are a large number of villages and populous places which have not been formed into special drainage districts. These may be classified according to population, thus—

127	villages	with a	population	of from	100	to	500
35	,,	,,	,,	,,	500	,,	1,000
14	,,	,,	,,	,,	1,000	,,	2,000
8	,,	,,	,,	,,	2,000,	upwards.	

Most of these villages are not sources of pollution, at least to any extent, but in a number of instances provision has been made for sewage purification. For example, at the village of *Tarbrax*, where there is a population of about 1,500, the sewage from the houses is irrigated on land. At the village of *New Lanark*, with a population of about 800, a septic tank and filter are in operation. At *Muirpark Rows, Bellshill* (population 650), there are tanks and filters; at *Blantyre Ferme Colliery Houses, Uddingston* (population 250), a tank and filter track; at *Newmains* (population 3,500), tanks and filters; and at *Canderdykehead Miners' Houses* (population 80), a tank and filter track have been provided. At these villages the houses are mostly owned by one proprietor.

Where the houses are owned by a number of proprietors, the only satisfactory procedure which can be adopted to

prevent pollution is to form the area into a special drainage district, with sewage purification works. On this subject numerous reports have been prepared from time to time by the sanitary inspectors and engineers of the three County sanitary districts, and reference might be made to a special report prepared for the Middle Ward District Committee by the Medical Officer of Health and District Engineer with regard to the formation of a special district to include most of the populous places in the Middle Ward. This report is dated 1st August, 1905, and showed the difficulties likely to be encountered in dealing with such a proposal.

PUBLIC INSTITUTIONS, &c.—There are also a number of public institutions and private residences provided with efficient means of sewage purification, of which the following might be mentioned:—

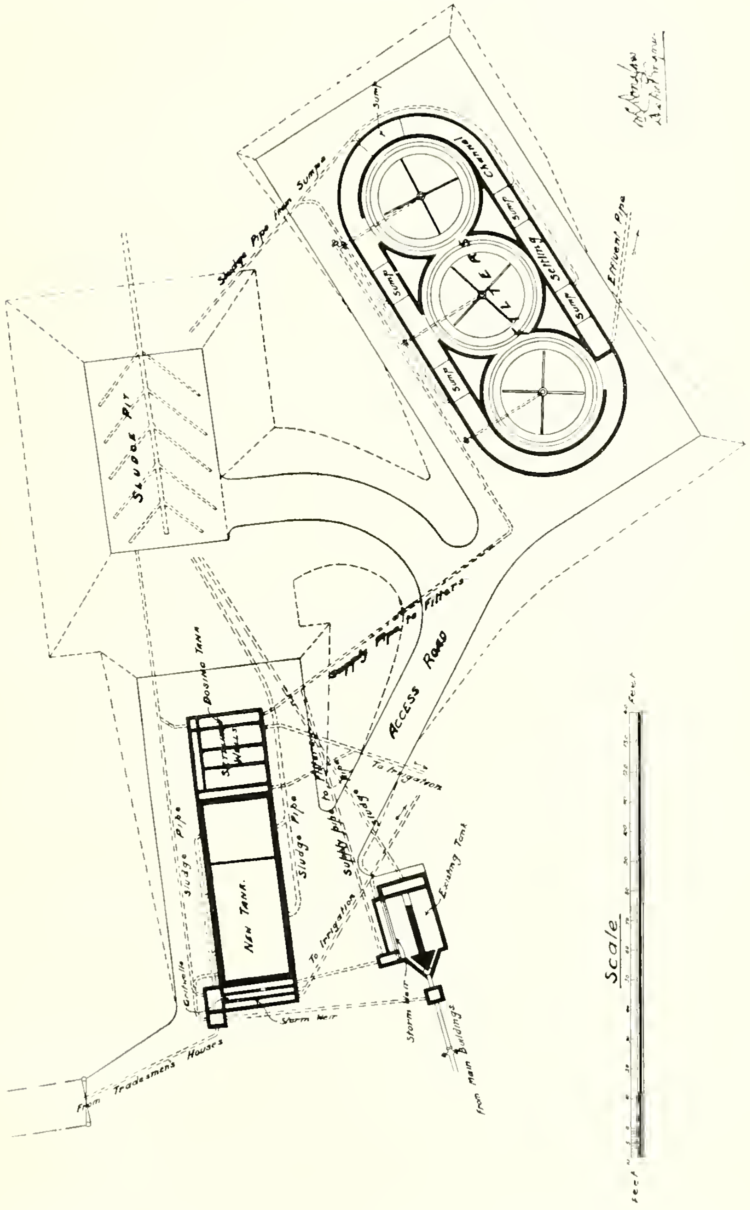
Lanark District Asylum.—This asylum has a population of about 1,000, and is situated at Hartwood, in Shotts Parish. The sewage is presently irrigated on lands belonging to the institution, which drain to the South Calder Water. A special sampling of the crude sewage and irrigated effluent took place on 11th September, 1907, and again on 2nd December, 1908. The analytical results showed that the purification effected was not satisfactory. New purification works have been designed by the Middle Ward District Engineer, and a plan of these is embodied in this report. They will comprise a septic tank and three continuous filters, and will be able to deal with the whole of the sewage, which can afterwards be irrigated on the lands at present in use. It will probably be desirable to pass some of the tank effluent direct on to the land.

Gartloch Asylum.—This asylum has a population of about 1,050, and is situated in the most southern corner of Cadder Parish, near Gartcosh. The sewage was at first treated by the "International system," comprising chemical precipitation and filtration. This method was, however, abandoned a year ago, and septic tanks and filters provided. The sewage effluent drains to the Bathlin Burn and the Bishop Loch.

County Isolation Hospitals in the Middle Ward are provided with tanks and filters. The largest of these hospitals is situated near Motherwell, and has a maximum population of about 250. The sewage purification works originally constructed were affected

LANARK DISTRICT ASYLUM, HARTWOOD.

PROPOSED SEWAGE WORKS.



some years ago by underground workings. New works are now about to be constructed on a site below the hospital and alongside the Sow Burn. The system to be adopted is tanks with double filtration, and the works will be of such a size as to deal not only with the hospital, but also with dwellings erected in the vicinity.

Small installations for sewage purification have also been provided for Hairmyres Reformatory, East Kilbride; Omoa Poorhouse, and Dalziel Poorhouse; the model lodging-houses at Shotts and at Cleland; the Tramway Power Station and Clyde Valley Electrical Generating Station at Motherwell.

SUMMARY.—The number of drainage areas tabulated at pages 43 and 44 may be summarised thus:—County drainage districts 32, with a population of **142,500**; burghs, 8, with a population of **183,990**—making 40 drainage areas, with a total population of **326,490.** The total number of drainage districts and burghs provided with sewage purification works is 26, with a total population of **175,775,** although in some instances the whole of the sewage has not yet been dealt with. Means of sewage purification have been planned, partly carried out, or are under consideration for *nine* districts, with a total population of about **74,785.** In *five* districts (including the burghs of Airdrie and Coatbridge), with a population of about **75,930,** there are no means for the prevention of pollution. Of the 26 districts provided with means of purification, additional works are to be provided in 7 of them.

The means adopted for the prevention or mitigation of sewage pollution are as follows:—*Irrigation* is carried out in *nine* districts, with a total population of about **46,008.** *Tanks and Filters* are in active operation in connection with *seventeen* districts, with a total population of about **129,767.**

In three of the irrigation systems the sewage is first passed through settling tanks. At eleven of the systems where tanks and filters are in use, the filters are worked as contact beds, or as continuous filters either with revolving sprinklers or tray distributors. In one district a tank and filtering tracks are in operation; and in five others tanks only are in use.

Chemical treatment with tank sedimentation has not been adopted in any of the districts of the county, but may be seen in operation on a large scale at the Glasgow Corporation Sewage Disposal Works at Dalmarnock and Dalmuir, and shortly also at Shieldhall.

From the investigations carried out by the inspectors at the various purification works constructed throughout the county, considerable experience has been gained. It will be remembered that the first works were constructed at Uddingston, and were brought into operation at the close of the year 1899. One of the first lessons learned was that the amount or volume of sewage to be dealt with could not be estimated from the population and water consumpt. Since then the principle has been laid down that no sewage scheme should be devised until once the actual flow has been carefully considered, and the character or quality of the sewage ascertained by analysis.

Experience has also shown that tanks, no matter how constructed, cannot dispose of solids without periodical and sometimes frequent cleaning out. At Uddingston, where the works were brought into operation in November, 1899, the total solids in the tank effluent at the first samplings varied from 57 parts per 100,000 in March to 115 parts per 100,000 in October, 1900, which showed that within a year the tank was not working satisfactorily. It will also be seen from the analyses in Appendix I. that the amount of suspended matter in septic tank effluents at other works varies from 4·6 to 21·2 parts per 100,000. The figures are given in the following Table. These results have been found to vary with the character of the sewage, the rate of flow through the tanks, the intervals between sludging, and the season of the year:

TABLE SHOWING THE AMOUNT OF SUSPENDED SOLIDS IN TANK EFFLUENTS IN RELATION TO CAPACITY, &c.

Sewage Work.	Tank.		Suspended Solids.	
	Capacity. D.W. Flow.	Time in Operation without Cleaning.	Percentage Reduction in Tank Effluent.	Amount in parts per 100,000.
Lanark,	28 hours,	4 years,	34	21·2
Motherwell,	24 ,,	8 months,	54	17·4
Hamilton,	14 ,,	27 ,,	—*	18·0
Strathaven,	8 ,,	20 ,,	17	29·4
Springwells,	8 ,,	15 ,,	46	5·6
East Kilbride,	10 ,,	4 ,,	50	6·0
Stepps,	8 ,,	1 month,	82	4·6

* 31 per cent. increase.

In order to prevent suspended matter, so far as possible, finding its way on to the filters, special settling wells have been constructed at some of the recent installations.

The main object of the tank is to remove suspended solids, without setting up so-called septic action. At Stepps Sewage Works, the passing of the crude sewage first into a Dortmund tank was tried, but without success, and the sewage is now first of all passed through the septic tank and thence to the Dortmund tank before going on to the percolating filter. The construction of tanks has undergone considerable modification both in size and design, and arrangements made for the frequent removal of deposited solids—still, there is room for improvement. Reference might be made to a form of tank devised by Dr. W. O. Travis, in use at Hampton-on-Thames, and called a Hydrolitic tank.

The special features of this tank have been recently described by a writer* as follows:—They are mainly associated with the more perfect deposition, and the more complete removal, of the impurities from the sewage, and have reference to—

(*a*) The exclusion of the main volume of liquid from a prolonged tank operation, and from the immediate environment of the sludge, in such a way as to prevent this volume being impregnated with the products of decomposition;

(*b*) the elimination of a proportion of the non-depositable finer suspended solids and colloidal matters;

(*c*) the further minimising of the outflow of suspended matter by the correction of the periodical flushes which are characteristic of the action of most tanks; and

(*d*) the efficiency of the provision for, and the easy method of, operating the removal of the accumulations during the continuous work of the tank.

Various efforts have been made to obviate the use of septic or sedimentary tanks, and using for preliminary treatment simply coarse filters, but these have been found to choke up readily. A system, however, has been devised by Mr. W. J. Dibdin to effect purification without the use of septic tanks, after preliminary screening, by contact treatment in what is known as a slate bed, regarding which Mr. Dibdin writes thus:—"As is well known, the 'slate bed' is an improved form of contact bed, which is

* Arthur E. Collins, M.Inst.C.E., City Engineer, Norwich. From paper read at Sessional Meeting of the Royal Sanitary Institute, held at Norwich on 22nd May, 1909.

filled with superposed layers of slate, separated at convenient distances, about 1 inch to 3 inches, as may be necessary, apart, by means of slate blocks, the whole thus forming an indestructible series of shelves, on which the sewage suspended matters are deposited when the beds are filled with sewage. As in the case of the old clinker coarse contact bed, the sewage is allowed to remain quiescent for two hours, when the outlet valve is opened and the 'primary effluent' run off for further treatment on land, contact or sprinkler beds, &c."

A large number of samples of sludge from septic tanks in different localities, taken when they were being cleaned out, have been examined. The analyses of these samples gave the following results:—

Water, ...	75 to 88 per cent.
Solids dried at 100° C. ...	12 to 25 ,,
Solids composed of—	
Mineral matter, ...	45 to 60 ,,
Volatile matter, ...	40 to 55 ,,
Iron, ...	1 to 5 ,,

With regard to the amount of sludge which accumulates in a tank, we have found that, stated in relation to the flow of sewage, the amount of wet sludge is about 1·2 cubic feet per 100,000 gallons of sewage.

The operation of cleaning out a tank by means of a pump, and especially when it is necessary to enter the tank, is liable to be somewhat offensive and trying to the workmen. So far as liability to nuisance to the public is concerned, however, there is practically no danger if the sludge is deposited at least 100 yards from any dwelling or public road.

A great deal has been learned with regard to the scientific basis upon which sewage purification proceeds. In this connection mention should be made of the work done by Dr. Dunbar, of Hamburg—a translation of his more important original paper is given in my Annual Report for 1906. His two main conclusions were as follows:—

1. The artificial biological methods of purification are derived from the natural biological processes of irrigation and intermittent filtration. In the latter, the purification process is completed in natural agricultural soil; in the former, one seeks to make good the soil by artificially prepared purification bodies—oxidising bodies, bacteria beds, contact beds, or percolation beds.

2. Just as in the natural, so also in the artificial, biological processes of purification procedure, so far as the removal of

dissolved putrefactive substances is concerned, rest upon *absorption*, *decomposition*, and *oxidation*. One must, therefore, strive so to construct the oxidation bodies that they, with the greatest possible development of surfaces, offer the most favourable conditions for the development of plant and animal life, and that they afford, as far as possible, uninterrupted entrance to the atmospheric oxygen.

As these views did not meet with general acceptance, Dr. Carnwath (now of Manchester) carried out some very interesting experiments, with the object of ascertaining "(1) whether 'mechanical filtration' is sufficient to explain the separation of a colloid from solutions as it occurs in a biological filter; (2) whether it is true that micro-organisms play no part in bringing about this separation; and (3) whether there is any truth in the view that air alone is sufficient to bring about the various oxidation changes that occur ordinarily in a ripe filter." These interesting experiments confirmed Dr. Dunbar's conclusions, and showed that both germ life and atmospheric oxygen were necessary for successful purification. Dr. Carnwath sums up the main points of his thesis thus:—

1. A biological filter eliminates from sewage dissolved putrescible substances almost immediately.
2. This elimination does not directly depend on the presence of micro-organisms.
3. As the substances in question are almost all colloidal, it is highly probable that the force at work effecting their elimination is absorption.
4. But absorption does not go on indefinitely. To ensure its continuance a change—"mineralisation"—must take place in the absorbed matters.
5. To initiate this change, oxygen alone is not sufficient; we require, in addition, the active presence of micro-organisms (and their ferments).
6. On the other hand, micro-organisms alone are also insufficient, although through them, no doubt, a partial "mineralisation" does occur. The products of this mineralisation, however, are quite as objectionable as the mother substances, as evil smelling, and with as great an affinity for oxygen, so that an effluent containing them can no more be considered pure than the original untreated influent.

The purification results obtained at the different sewage purification works throughout the county may be gathered from the details of analyses in Appendix No. I. In the chemical analyses no reference is made to the physical characters, and yet in forming an opinion as to the degree of purification carried out the physical appearances are very instructive.

The amount of purification effected at most of the sewage purification works where sufficient sampling has been done varies considerably, but the average amount may be stated at about 60 per cent. These figures are calculated on the oxygen absorbed and the albuminoid ammonia, indeed, it is customary to speak of the percentage purification in terms of the reduction which takes place in these two factors. In the following Table the reduction of organic matter is shown in comparison with the strength of sewage, which is also calculated upon the figures for oxygen absorbed and albuminoid ammonia. Thus, in the case of Lanark sewage, the oxygen absorbed was 4·67, and the albuminoid ammonia ·792. The mean of these two figures is 2·73. The corresponding mean for the filter effluent was 1·4, showing a reduction of 1·33, or about 50 per cent.:—

TABLE SHOWING THE RELATION OF PURIFICATION EFFECTED TO THE STRENGTH OF THE SEWAGE AND THE RATE OF FILTRATION.

SEWAGE WORKS.	Sewage. Strength estimated by amount of Organic matter. (Parts per 100,000.)	Sewage. Rate of Flow per cubic yard of material. Single Contact Filters.	Sewage. Rate of Flow per cubic yard of material. Percolating Filters.	Reduction of Organic Matter by Filtration. Total parts per 100,000.	Reduction of Organic Matter by Filtration. Percentage.
		Gallons.	Gallons.		
Lanark, - -	2·73	...	137	1·33	50
Strathaven, - -	1·88	180	...	·87	51
Motherwell, - -	3·85	...	74	2·72	73
Hamilton, - -	1·91	178	..	1·38	70
Cleland and Omoa,	5·62	200	...	4·64	82
Blantyre—Springwells, -	2·82	...	455	1·43	56
Uddingston, -	1·59	138	...	·82	47
East Kilbride, -	2·43	112	...	1·74	66

These estimates of the purification effected would be considerably lower if, instead of the sewage, the tank effluent were compared with the filter effluent. The crude sewage sampled during the day, even over a period of twelve hours, is much stronger than the sewage during the night, so that when the tank is of considerable size the effect of the strong day sewage is not fully felt at the tank outlet. In those cases where night sampling has been done it has been invariably found that the tank effluent during the night is slightly stronger than the crude sewage; in other words, the equalising effect of the tank tends to improve the results of the day samples.

In the Summary of Conclusions and Recommendations of the Royal Commission, contained in their fifth Report (see page 117 of this Report), the tests for sewage effluents in relation to standards are (1) the amount of suspended matter, and (2) the rate at which the effluent takes up dissolved or atmospheric oxygen.

(1) The amount of suspended solids has always been estimated, generally by filtration of an aliquot portion through a weighed filter paper, although in a few instances the result is the difference between total and dissolved solids. In average samples of final effluent, the amount of suspended solids present varied considerably. Omitting two localities where the suspended solids were unusually high, the amount varied from 2·8 to 12·0 parts per 100,000, while the average was 5·0 parts per 100,000. The average standard laid down by the Royal Commission is 3·0 parts per 100,000.

(2) The rate of absorption of atmospheric oxygen has been estimated in most samples of effluent which have been examined during the present year. The amount of dissolved oxygen has also been estimated in a few samples of effluent and in samples from streams affected by sewage effluents. In the latter the estimations have been made by the method described by Professor Letts in the Fifth Report of the Royal Commission on Sewage Disposal (Appendix VI., page 221), while the rate at which an effluent will absorb atmospheric oxygen has been measured in an apparatus designed by Dr. Adeney, slightly modified from that described in *The Analyst*, 1909, page 42, and the results are given in the following Table:—

Atmospheric Oxygen absorbed by Average Samples of Filter Effluent, as measured in Dr. Adeney's Apparatus.

Description of Effluent.	Results: Parts per 100,000.		
	24 Hours.	48 Hours.	5 Days.
Motherwell Effluent.	·89	...	..
Biggar ,,	·41	·80	
Lanark ,,	·44	1·16	
Strathaven ,,	1·16	1·43	
East Kilbride ,,	·53	1·20	...
Provisional Standard,	·5	1·0	1·5

With regard to the amount of atmospheric oxygen absorbed, sufficient work has perhaps not been done to enable one to express a definite opinion. Generally speaking, however, the results obtained have been rather higher than the standard laid down. This may be due to a slight modification of the method described, which states that the effluents shall be filtered through paper before estimating the amount of oxygen absorbed. The method adopted has been to syphon off a portion after getting rid of suspended solids by sedimentation. Perhaps, in order to determine the amount of oxygen which an effluent requires for the oxidation of the organic matter present, it would be more desirable to include any suspended solids it might contain. The suspended solids usually contain a large proportion of organic matter which undoubtedly has the property of absorbing oxygen, but in the recommendations by the Royal Commission this is to be neglected. Again, in filtering an effluent through filter paper, an amount of oxygen will be absorbed which will probably vary with the rate of filtration, thus rendering it impossible to get similar results from duplicate estimations.

The results of purification by chemical precipitation at Dalmarnock Sewage Works are summed up by Mr. M'Donald in these words:—"The sewage treatment eliminates every trace of suspended matter, and effects 50 per cent. of chemical purification.

calculated on the albuminoid ammonia basis." The percentage purification obtained at Dalmuir is said to be lower than that accomplished at Dalmarnock, but the difference is accounted for in the less concentrated initial quality of the crude sewage treated at Dalmuir. In other words, the Dalmuir sewage, being less bad to begin with, needs less improvement than the Dalmarnock sewage.

The effluent discharged at Dalmarnock in relation to the volume in the River Clyde is stated thus:—At Dalmarnock, 16 million gallons is discharged into a tidal stream of fifty-fold volume. At Shieldhall and at Dalmuir, 96 million gallons of effluent will come in contact with 3,000 million gallons of tidal water.

The results of the experience gained might be summed up thus:—

(1) Before sewage purification works are designed, accurate information should be obtained as to the volume of sewage to be dealt with, and as to the character or quality of the sewage. (2) Tanks should be so designed as to permit of the frequent removal of sludge in such a way as not to create a nuisance. The size and construction of tanks should also be such as to permit as little septic action as possible. (3) Filters—The principles on which purification by filtration proceeds have been shown to consist of (*a*) a physical process of absorption, (*b*) the action of germ life, and (*c*) oxidation by atmospheric oxygen. The filtering material should therefore be of a durable substance, with surfaces not too smooth. The tank effluent should be as free as possible from suspended solids, otherwise the absorption process is interfered with. The fineness of the filtering material will depend upon the strength of the tank effluent, but it should always be sufficiently open to allow of proper aeration. (4) In determining the degree of purification effected, the power of absorbing oxygen from the air, and especially the dissolved oxygen from water, might form the best criterion in fixing a standard for any sewage purification plant. Regard must also be had to the character of the stream into which the effluent is to be discharged, and to other local circumstances. (5) With regard to village communities, experience shows that the adoption of laws for the prevention of pollution may be a hindrance instead of an aid to the promotion of domestic sanitation. For example, in a country village, where the liquid refuse is either thrown on to the garden ground

or into the road surface channels, there is seldom cause for complaint of pollution, but where a drain has been laid to convey the sewage direct from the dwellings to the nearest ditch or stream, complaints of pollution are liable to arise. Again, not infrequently owners of property, when asked to provide a water carriage system of sewage disposal and to abolish midden privies, point out the difficulties of avoiding complaint from riparian proprietors. We have had numerous examples of this. Not only is the volume of sewage considerably increased, but there is a very strong belief that sewage containing excremental refuse from water-closets is much more objectionable and dangerous than sewage consisting only of household slops. Chemical analysis does not support this belief.

In this connection mention might be made of the recent action against proprietors in the village of Netherburn, and the suggested action in the village of Salsburgh. A farmer has some losses amongst his cattle, and a veterinary surgeon states that the illnesses may have been due to the pollution of the stream to which the cattle had access, and claims for damage and consequent litigation at once arise. A local authority in such circumstances will hesitate to form a special drainage district and construct sewerage, unless ample provision can be made for sewage purification, which might involve such an outlay as would necessitate the imposition of a very high rate of assessment, and thus make the formation of a drainage district impossible.

Again, where drainage districts have been formed for small communities, and sewage purification works provided, similar complaints have been raised by farmers, and reference might be made to the experiences at East Kilbride and Carnwath. There is no system of sewage purification in operation which will produce an effluent fit for primary purposes. It is easy to show from chemical and bacteriological analysis that some pollution is taking place, but I am satisfied that the allegations made as to streams receiving such sewage effluents being injurious to cattle are not well founded, and reference might be made in this connection to some of the evidence led in the action against the Town Council of Maybole by a farmer complaining of the pollution of a burn which has its source in a sheet of water used as a place of deposit for the refuse of the burgh. This action is fully referred to in *The Journal of Comparative Pathology*, March, 1906. Reference could also be made to many other similar cases.

Having regard to all these experiences, one welcomes the recommendation in the Fifth Report of the Royal Commission on Sewage Disposal that—

"No action should be allowed to be brought in respect of damage alleged to be due to the discharge of an effluent which complies with the standard fixed for the water into which it is discharged, but that in such cases complaint should be made to the Central Authority, and, if a *prima facie* case is made out, that authority should ascertain whether the complaint is well founded, and should be empowered to fix a different standard if the circumstances are shown to require it."

IV.—THE CLYDE AND ITS TRIBUTARIES.

The condition of the River Clyde and its tributaries is dealt with in the special report of 1903, where these streams are considered first as a source of water supply, and then as affected by pollution—pages 127 to 145. There can be no doubt that a considerable improvement has taken place at many places where serious pollution was reported in 1903, but it is difficult to show any great improvement upon the Clyde itself by the usual chemical analysis. Since the year 1902 six series of samples have been taken from the River Clyde at points that were considered suitable for forming an opinion as to the condition of the river Whether these points are suitably chosen is well worthy of discussion. When the object of sampling is to show the effect of a tributary or polluting outfall on any stream, the usual procedure is to take three samples—one from a point immediately above the outfall, one of the outfall itself, and one a short distance below the outfall; but, if it is desired to show from time to time the condition of a stream like the River Clyde, which from Hamilton downwards is about two hundred and fifty feet wide from bank to bank, it is necessary that sampling should be done at a point removed from polluting outfalls. Such samples will show the average condition of the water. At Hamilton and Motherwell Railway Bridge there is no polluting discharge within 500 yards from the point of sampling, and, similarly down the course of the river, the points fixed are as far as possible removed from sewer outfalls or polluting tributaries.

All these samples were submitted to the usual chemical analysis and the detailed results are recorded in the Special Report of 1903. and in the Annual Reports since that year. These analyses show that the River Clyde undergoes considerable deterioration as it approaches the City of Glasgow. From Hamilton onwards a considerable quantity of sewage and industrial pollution enters at various points, but not in such quantities as to seriously interfere with the natural purification that takes place in a running stream. The amount of polluting liquid in relation to the volume of water in the river is such as to allow the purifying process to go on so that the river quickly recovers from the effect of each polluting outfall, or tributary, until it approaches the City of Glasgow.

In the details of the chemical analyses this deterioration is shown by the increased amount of nitrogenous substances. The amount

of oxidisable material, as determined by the usual method of "Oxygen Absorbed from Permanganate," is of little value, since a comparatively pure river like the Avon, which is liable at times of the year to be very peaty, will absorb as much oxygen as that of the River Clyde in its most polluted state. Probably the new method adopted by the Commission will be found the most reliable test for determining the condition of a stream in relation to pollution, but the nitrogen figures so far as available are here given.

The curves on the following page represent the amount of total nitrogen from free and albuminoid ammonia found in samples taken from the River Clyde at different places or points between Hamilton and Whiteinch on six different dates. Each horizontal dotted line represents ·10 part total nitrogen per 100,000, and also serves as a base or zero line for the curve commencing immediately above it.

PLACES OR POINTS OF SAMPLING.

Point of Sampling.	Reference Number.		Point of Sampling.
Hamilton and Motherwell Railway Bridge,	1	7	Dalmarnock Bridge.
Bothwell ,, ...	2	8	Rutherglen ,,
Blantyre ,, ...	3	9	Glasgow Weir.
Haughhead ,, ...	4	10	Broomielaw Ferry.
Carmyle Weir, ...	5	11	Kelvinhaugh.
Clyde Iron Works, ...	6	12	Whiteinch.

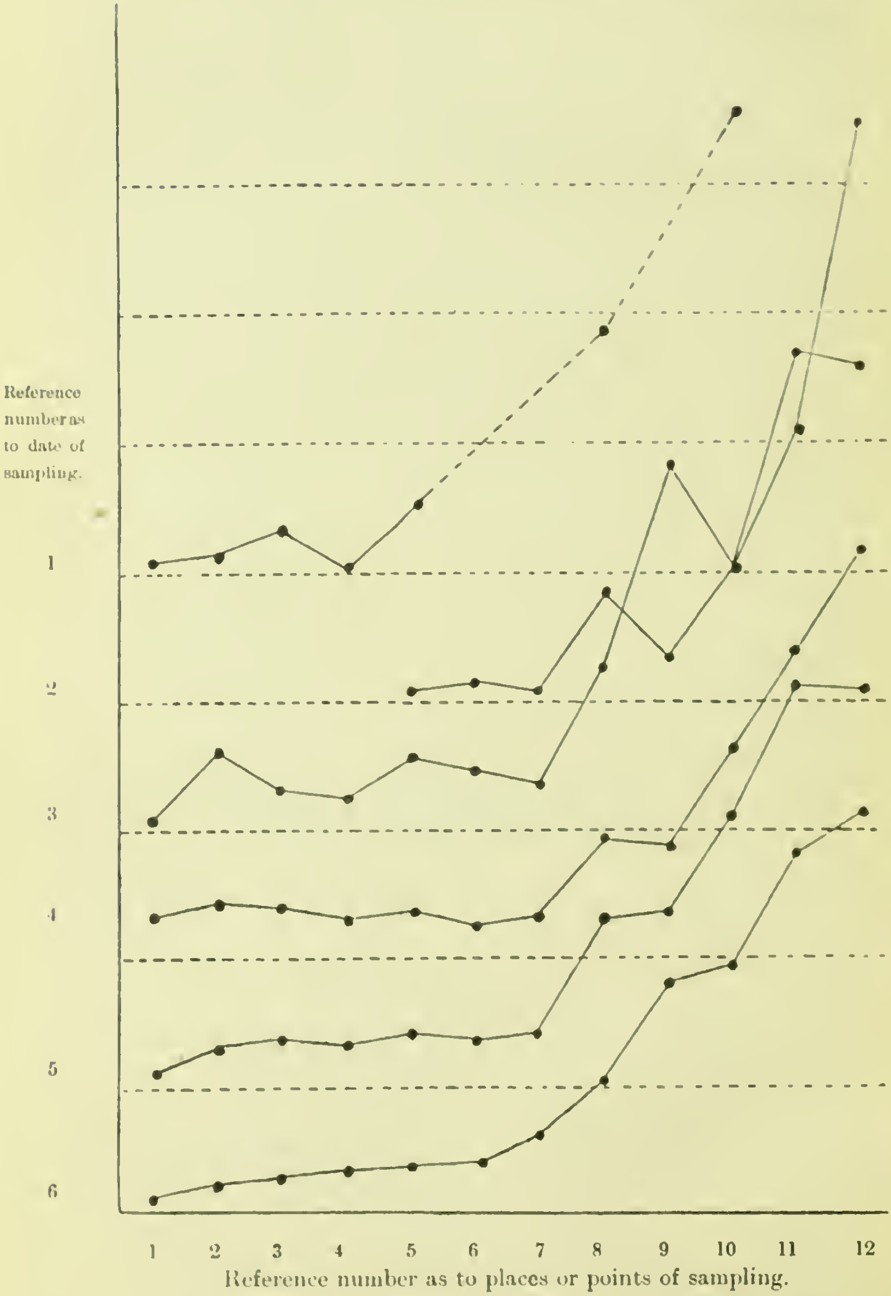
DATES OF SAMPLING AND RAINFALL.

Curve Reference Number.	Year.	Month.	Rainfall on 5 preceding days.
1	1902	September 25th,	·23
2	1902	October 6th, ...	Nil.
3	1903	August 26th, ...	·15
4	1904	August 8th, ...	1·05
5	1904	September 16th,	Nil.
6	1907	July 24th, ...	Nil.

This is an average of the total rainfall at three stations, viz., Leadhills, Bothwell, and Glasgow.

SAMPLING THE RIVER CLYDE BETWEEN HAMILTON AND GLASGOW.
POLLUTION SHOWN BY CURVES.

The space between each horizontal dotted line represents ·1 part total nitrogen



The River Clyde, according to the Ordnance Survey 1857-8, was considered tidal as far up as Carmyle Weir, whereas, according to the Ordnance Survey of 1897, the highest point to which ordinary spring tides flow was shown at a point opposite Clyde Paper Mills, that is, about three miles below Carmyle Weir. In connection with the legal proceedings for the prevention of pollution from Clyde Iron Works, which are situated between these two points, information was obtained in 1896 from the engineer of the Clyde Navigation (the late Mr. James Deas), which showed that observations had been carried out under his direction during the years 1880 to 82, when he ascertained that "the ordinary spring tides of average high water level in Glasgow Harbour flowed as far up as Westthorn." This practically agrees with the Ordnance Survey of 1897.

On behalf of the County Council, a series of observations were made by Mr. Alex. Frew, C.E., in the latter half of September, 1902. The first point of observation was immediately above the weir at Glasgow Green, the second was at Dalmarnock Bridge, about two miles further up the river, and the third at the outfall from Clyde Iron Works.

The observations were confined to day-light tides between the 15th and 26th September—a period which included a series of spring tides—and show that the average rise in level of full tides at Glasgow Green was 2·22 feet, that at Dalmarnock Bridge the rise was 3 inches higher, and that at Clyde Iron Works there was no variation. This indicated that the limit at the place where ordinary spring tides reaches was between Dalmarnock Bridge and Clyde Iron Works, and that therefore the new Ordnance Survey was correct.

For the defenders, observations were carried out by Mr. John Cowan, C.E., and his evidence went to show that the river was tidal a long distance above the point shown on the Ordnance Survey of 1897.

After hearing proof, the Sheriff-Substitute held that "at the point in question the Clyde had all the characteristics of an ordinary fresh-water stream. It is confined by banks, and the river water contends from bank to bank. There are no sands or flats left dry at low tide, and there is no evidence to show that salt water ever reaches the defenders' works, or that an upward movement or flow of the water is ever perceptible there."

APPENDIX I.

RECORDS OF SAMPLING.

CHEMICAL ANALYSES.

RESULTS STATED IN PARTS PER 100,000.

I.—Samples taken from Sewage Purification Works.

BIGGAR BURGH—WEST-END SEWAGE PURIFICATION WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 6 A.M. TILL 4 P.M., 9TH JUNE, 1909.

a.m	Gallons.	p.m.	Gallons.
7.	6,453	12.	5,806
8.	6,072	1.	6,072
9.	5,933	2.	6,072
10.	5,806	3.	6,072
11.	5,673	4	6,072

Total flow, 10 hours, 60,031 gallons.

TABLE B.—AVERAGE HOURLY SAMPLES OF SEWAGE, TANK, AND IRRIGATED EFFLUENT.

	Chlorides			Oxygen Absorbed		
a.m	Sewage.	Tank.	Effluent.	Sewage.	Tank.	Effluent.
7.	2·2	2·0	1·8	·37	·42	·45
8.	3·0	2·6	1·8	1·15	1·22	·40
9.	3·4	3·4	1·8	2·46	2·34	·48
10.	4·2	4·4	1·8	2·29	2·47	·50
11.	3·6	4·0	2·0	2·26	2·54	·57
12.	4·0	3·8	2·6	2·36	2·46	·72
1.	4·6	4·4	3·0	2·49	3·04	·74
2.	5·0	7·0	3·2	2·06	2·54	·76
3.	5·2	5·0	3·6	3·78	2·54	·86
4.	4·0	5·0	3·8	2·40	2·68	·78
Mean,	3·9	4·1	2·5	2·16	2·22	·62

BIGGAR BURGH—WEST-END SEWAGE PURIFICATION WORKS—*Continued.*

Table C.—Two Three-Hourly Samples and One Four-Hourly Average Sample of Irrigated Effluent.

	6-9 a.m.	9-12 noon.	12-4 p.m.	Mean.
Chlorides, ...	1·8	2·3	3·5	2·6
Oxygen Absorbed, ...	·49	·66	·78	·64
Nitrites as Nitrogen, ...	Present.	Present.	Present.	Present.
Nitrates ,, ,, ...	·136	·096	·057	·096
Ammonia, Free Nitrogen, ...	·201	·262	·611	·358
,, Albuminoid Nitrogen,	·044	·041	·076	·054
Total Ammoniacal Nitrogen, ...	·245	·303	·687	·412
Solids, Total, ...	12·6	10·2	20·6	14·5
,, Volatile, ...	9·6	4·2	10·2	8·0
,, Suspended, ...	2·2	2·0	3·2	2·8

Table D.—Average Sample of Sewage, Tank, and Irrigated Effluent.

	Sewage.	Tank.	Effluent.
Chlorides, ...	3·9	4·2	2·6
Oxygen Absorbed, ...	2·51	2·26	·66
Nitrites as Nitrogen, ...	Nil.	Nil.	Present.
Nitrates ,, ,, ...	Nil.	Nil.	·084
Ammonia, Free Nitrogen, ...	·816	1·433	·297
,, Albuminoid Nitrogen, ...	·200	·281	·041
Total Ammoniacal Nitrogen, ...	1·016	1·714	·338
Solids, Total, ...	30·0	27.6	15·2
,, Volatile, ...	17·6	17·6	5·6
,, Suspended, ...	11·6	8·2	2·8

LANARK BURGH—SEWAGE PURIFICATION WORKS.

Table A.—Hourly Flow of Sewage from 7.30 a.m. to 7.30 p.m., 6th July, 1909.

a.m.	Gallons.	p.m.	Gallons.
8.30.	15,194	2.30.	13,204
9.30.	25,682	3.30.	12,514
10.30.	24,705	4.30.	23,874
11.30.	14,683	5.30.	25,139
p.m. 12.30.	13,711	6.30.	13,052
1.30.	13,204	7.30.	13,082

Total flow, 12 hours, 208,644 gallons.

Table B.—Average Hourly Samples of Sewage, Tank, and Filter Effluent.

	Chlorides.			Oxygen Absorbed.		
a.m.	Sewage.	Tank.	Filter.	Sewage.	Tank.	Filter.
8.30.	17·6	4·6	4·4	2·91	1·89	3·15
9.30.	6·8	5·0	4·4	3·19	1·90	2·12
10.30.	5·4	5·8	4·8	4·57	1·86	1·74
11·30.	6·4	6·4	6·0	3·47	1·91	2·38
12.30.	15·4	6·6	6·2	5·71	2·04	2·20
p.m. 1.30.	23·4	6·4	6·2	6·39	3·05	2·60
2.30.	15·2	6·4	6·0	5·50	2·36	2·48
3.30.	9·2	6·6	6·4	6·42	2·39	2·00
4.30.	6·8	7·6	6·4	6·52	2·50	2·41
5.30.	5·4	8·6	7·6	4·54	3·15	2·38
6.30.	7·2	9·0	10·0	3·01	3·66	2·22
7.30.	5·8	8·6	8·	4·46	3·42	2·41
Mean,	10·4	6·8	6·4	4·72	2·51	2·35

LANARK BURGH—SEWAGE PURIFICATION WORKS—*Contd.*

Table C.—Average Three-Hourly Samples of Filter Effluent.

	7.30-10.30.	10.30-1.30.	1.30-4.30.	4.30-7.30.	Mean.
Chlorides, ...	4·5	6·2	6·2	8·8	6·4
Oxygen Absorbed, ...	2·34	2·40	2·30	2·37	2·35
Nitrites as Nitrogen,	Abundant.	Abundant.	Abundant.	Abundant.	Abundant.
Nitrates ,, ,,	·720	·657	·676	·449	·625
Ammonia, Free Nitrogen,	1·344	1·844	1·808	2·152	1·787
,, Albuminoid Nitrogen,	·240	·244	·228	·292	·251
Total Ammoniacal Nitrogen,	1·584	2·088	2·036	2·444	2·038
Solids, Total, ...	47·0	47·0	47·2	48·0	47·3
,, Volatile, ...	24·8	23·0	21·2	20·2	22·3
,, Suspended, ...	23·8	24·8	13·2	11·4	18·3

Table D.—Average Twelve-Hourly Samples of Sewage, Tank, and Filter Effluent.

	Sewage.	Tank.	Filter.
Chlorides, ...	10·3	6·8	6·4
Oxygen Absorbed, ...	4·67	2·38	2·43
Nitrites as Nitrogen, ...	Nil.	Nil.	Abundant.
Nitrates ,, ,, ...	Nil.	Nil.	·644
Ammonia, Free Nitrogen, ...	3·072	2·284	1·716
,, Albuminoid Nitrogen, ...	·792	·348	·368
Total Ammoniacal Nitrogen, ...	3·864	2·632	2·084
Solids, Total, ...	78·0	51·2	55·0
,, Volatile, ...	39·4	27·2	25·0
,, Suspended, ...	32·4	21·2	30·4

MOTHERWELL BURGH—COURSINGTON SEWAGE PURIFICATON WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 8 A.M. TO 8 P.M., 20TH APRIL, 1909.

a.m.	Gallons.	p.m.	Gallons.
9.	22,595	3.	22,934
10.	23,652	4.	23,652
11.	23,402	5.	23,652
12.	23,652	6.	24,449
p.m. 1.	25,772	7.	24,427
2.	24,199	8.	22,037

Total flow, 12 hours, 284,423 gallons.

TABLE B.—AVERAGE HOURLY SAMPLES OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Chlorides.			Oxygen Absorbed		
a.m.	Sewage.	Tank.	Filter	Sewage.	Tank	Filter.
9.	5·6	4·0	4·6	6·16	3·53	1·56
10.	5·8	4·2	4·6	4·25	3·81	1·71
11.	4·0	4·6	4·6	6·60	4·10	1·91
12.	4·0	4·6	4·2	15·20	4·14	1·92
p.m. 1.	5·4	5·0	4·6	6·82	4·64	2·13
2.	9·6	2·0	4·2	6·76	5·16	2·12
3.	4·4	2·2	4·6	6·85	5·26	1·93
4.	7·2	6·8	4·8	6·69	4·98	2·17
5.	2·4	2·6	4·8	6·89	5·43	2·39
6.	1·6	3·4	5·4	6·65	5·44	2·06
7.	5·4	3·4	5·4	6·73	5·47	1·85
8.	2·0	3·0	5·8	5·48	4·25	1·83
Mean,	4·7	3·8	4·8	7·09	4·68	1·96

MOTHERWELL BURGH—COURSINGTON SEWAGE PURIFICATION WORKS—*Continued.*

TABLE C.—AVERAGE THREE-HOURLY SAMPLES OF FILTER EFFLUENT.

	8-11 a.m.	11-2 p.m.	2-5 p.m.	5-8 p.m.	Mean.
Chlorides, ...	4·6	4·4	5·0	5·4	4·9
Oxygen Absorbed, ...	1·96	2·06	2·20	1·93	2·04
Nitrites as Nitrogen,	Present.	Abundant.	Abundant.	Abundant.	Abundant.
Nitrates ,, ,,	1·500	1·292	1·020	1·161	1·243
Ammonia, Free Nitrogen,	·308	·440	·440	·668	·464
,, Albuminoid Nitrogen,	·152	·208	·224	·180	·191
Total Ammoniacal Nitrogen,	·460	·648	·664	·84	·655
Solids, Total, ...	51·0	62·0	52·0	53·8	54·7
,, Volatile, ...	21·0	30·0	18·0	22·8	22·9
,, Suspended, ...	7·0	17·4	3·4	7·2	8·7

TABLE D.—AVERAGE TWELVE-HOURLY SAMPLES OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Sewage.	Tank.	Filter.
Chlorides, ...	6·6	4·6	4·8
Oxygen Absorbed, ...	6·86	4·82	2·05
Nitrites as Nitrogen, ...	Nil.	Nil.	Abundant.
Nitrates ,, ,, ...	Nil.	Nil.	1·424
Ammonia, Free Nitrogen, ...	3·672	2·164	·540
,, Albuminoid Nitrogen, ...	·840	·400	·204
Total Ammoniacal Nitrogen, ...	4·512	2·56	·744
Solids, Total, ...	61·2	40·2	54·0
,, Volatile, ...	38·2	28·0	26·0
,, Suspended, ...	38·2	17·4	12·0

HAMILTON BURGH—PARK BURN SEWAGE PURIFICATION WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 8 A.M. TO 8 P.M., 23RD MARCH, 1909.

a.m.	Gallons.	p.m.	Gallons.
9.	22,280	3.	30,260
10.	23,420	4.	33,920
11.	23,420	5.	39,000
12.	33,670	6.	30,000
p.m. 1.	39,240	7.	34,050
2.	32,280	8.	35,030

Total flow, 12 hours, 376,570 gallons.

TABLE B.—AVERAGE HOURLY SAMPLES OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Chlorides.			Oxygen Absorbed.		
a.m.	Sewage.	Tank.	Filter.	Sewage.	Tank.	Filter.
9.	6·4	5·8	5·8	2·63	2·08	·56
10.	6·8	5·4	5·9	3·07	2·44	·54
11.	7·2	5·4	6·0	3·05	2·60	·58
12.	7·8	5·6	5·3	3·75	2·61	·67
p.m. 1.	7·6	5·8	5·7	5·59	2·65	·89
2.	8·4	6·0	5·5	3·28	3·05	·95
3.	8·2	6·4	5·9	3·22	3·05	1·05
4.	7·8	6·6	6·1	3·55	3·09	1·18
5.	6·6	7·0	6·1	3·60	3·09	1·45
6.	6·2	6·8	5·4	3·60	3·44	1·18
7.	6·0	6·6	7·2	3·10	3·61	1·23
8.	5·0	6·4	6·4	2·64	3·53	1·33
Mean.	7·0	6·1	5·9	3·42	2·93	·97

HAMILTON BURGH—PARK BURN SEWAGE PURIFICATION WORKS.—*Continued.*

Table C.—Average Three-Hourly Samples of Filter Effluent.

	8-11 a.m.	11-2 p.m.	2-5 p.m.	5-8 p.m.	Mean.
Chlorides, ...	5·8	5·6	6·0	6·4	5·9
Oxygen Absorbed, ...	·57	1·09	1·28	1·22	1·04
Nitrites as Nitrogen, ...	Present.	Present.	Abundant.	Nil.	Abundant.
Nitrates ,, ...	·342	·244	·292	·248	·281
Ammonia, Free Nitrogen, ...	·284	·832	·792	·760	·667
,, Albuminoid Nitrogen,	·100	·060	·088	·120	·092
Total Ammoniacal Nitrogen, ...	·384	·892	·880	·880	·759
Solids, Total, ...	63·0	60·2	58·0	54·0	58·8
,, Volatile, ...	24·0	22·8	20·4	22·0	22·3
,, Suspended, ...	3·8	8·4	4·0	6·0	5·5

Table D.—Average Twelve-Hourly Samples of Sewage, Tank, and Filter Effluent.

	Sewage.	Tank.	Filter.
Chlorides, ...	6·8	6·0	5·8
Oxygen Absorbed, ...	3·48	3·05	·96
Nitrites as Nitrogen, ...	Nil.	Trace.	Abundant.
Nitrates ,, ...	Nil.	Nil.	·364
Ammonia, Free Nitrogen, ...	2·064	1·640	·664
,, Albuminoid Nitrogen,	·336	·344	·112
Total Ammoniacal Nitrogen, ...	2·400	1·984	·776
Solids, Total, ...	70·8	68·0	60·8
,, Volatile, ...	30·6	30·0	18·0
,, Suspended, ...	13·6	18·0	4·8

MIDDLE WARD DISTRICT—STRATHAVEN SEWAGE PURIFICATION WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 8 A.M. TO 8 P.M., 17TH AUGUST, 1909.

a.m.	Gallons.	p.m.	Gallons.
9.	18,444	3.	18,968
10.	18,444	4.	17,920
11.	18,444	5.	25,718
12.	18,444	6.	17,396
p.m. 1.	18,444	7.	16,872
2.	16,872	8.	15,840

Total flow, 12 hours, 221,806 gallons.

TABLE C.—AVERAGE THREE-HOURLY SAMPLES OF FILTER EFFLUENT.

	8-11 a.m.	11-2 p.m.	2-5 p.m.	5-8 p.m.	Mean.
Chlorides, ...	3·0	4·0	4·0	4·0	3·75
Oxygen Absorbed, ...	1·57	1·89	1·57	1·83	1·71
Nitrites as Nitrogen, ...	*Present.	Present.	Present.	Present.	Present.
Nitrates ,, ...	·758	·467	·475	·406	·526
Ammonia, Free Nitrogen, ...	·456	1·328	1·096	1·344	1·056
,, Albuminoid Nitrogen,	·136	·216	·136	·192	·170
Total Ammoniacal ,,	·592	1·544	1·232	1·536	1·226
Solids, Total, ...	56·4	54·6	59·8	60·0	57·7
,, Volatile, ...	24·2	30·0	22·0	25·8	25·5
,, Suspended, ...	30·0	28·2	32·6	35·0	31·4

* Nitrites as nitrogen = ·002, ·003, ·012, and ·006.

MIDDLE WARD DISTRICT.—STRATHAVEN SEWAGE PURIFICATION WORKS—*Continued.*

TABLE D.—AVERAGE TWELVE-HOURLY SAMPLES OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Sewage.	Tank.	Filter.
Chlorides, ...	4·4	4·0	3·6
Oxygen Absorbed, ...	3·29	2·84	1·83
Nitrites as Nitrogen, ...	Nil.	Nil.	Present.*
Nitrates ,, ,, ...	Nil.	Nil.	·403
Ammonia, Free Nitrogen, ...	1·720	1·476	·900
,, Albuminoid Nitrogen,	·464	·340	·192
Total Ammoniacal Nitrogen, ...	2·184	1·816	1·092
Solids, Total, ...	61·4	52·0	58·8
,, Volatile, ...	32·0	20·0	22·8
,, Suspended, ...	35·4	29·4	35·4

* Nitrites as Nitrogen, ·006.

MIDDLE WARD DISTRICT—SPRINGWELLS SEWAGE PURIFICATION WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 9 P.M. TO 9 P.M., 25TH AND 26TH MARCH, 1907.

p.m.	Gallons.	a.m.	Gallons.
10.	2,102	10.	2,362
11.	2,036	11.	2,021
12.	2,250	12.	2,214
a.m.		p.m.	
1.	2,250	1.	2,295
2.	2,250	2.	2,295
3.	2,250	3.	2,176
4.	2,250	4.	2,127
5.	2,340	5.	2,361
6.	2,340	6.	2,472
7.	2,250	7.	2,531
8.	2,250	8.	2,449
9.	2,295	9.	2,362

Total flow, 24 hours, 54,528 gallons.

MIDDLE WARD DISTRICT—SPRINGWELLS SEWAGE PURIFICATION WORKS—*Continued.*

TABLE B.—AVERAGE HOURLY SAMPLES OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Chlorides			Oxygen Absorbed.		
p.m.	Sewage.	Tank	Filter	Sewage	Tank	Filter
10.	4·0	5·4	...	1·23	2.02	...
11.	3·6	5·4	...	·84	2·44	...
12.	3·0	5·0	...	·84	3·44	...
a.m.						
1.	2·6	5·0	...	·49	1·82	...
2.	2·8	4·6	...	·48	1·90	...
3.	2·3	4·2	...	·44	1·19	...
4.	2·2	3·8	...	·41	1·14	...
5.	2·4	3·8	...	·43	1·17	...
6.	2·4	3·4	...	·48	·99	...
7.	3·0	3·2	...	·81	·84	...
8.	3·2	3·2	...	1·42	·77	...
9.	4·4	3·0	...	2·20	·94	...
10.	4·0	3·0	3·2	3·66	1·46	1·28
11.	4·6	3·0	3·2	3·52	1·04	1·22
12.	5·0	3·2	3·4	6·75	2·00	1·42
p.m.						
1.	7·2	3·8	3·6	6·04	2·26	1·76
2.	4·8	4·4	3·8	6·65	2·70	1·07
3.	5·2	4·8	4·2	4·64	3·42	2·23
4.	4·4	4·8	4·6	3·75	3·37	2·83
5.	5·2	4·8	5·0	6·04	4·27	3·33
6.	4·4	4·6	5·0	5·82	2·77	2·31
7.	4·2	4·8	4·8	7·04	4·99	3·82
8.	4·6	5·0	3·2	4·71	5·49	3·79
9.	4·0	4·8	5·0	1·68	5·91	4·14
Mean,	3·9	4·2	4·1	2·93	2·47	2·5

MIDDLE WARD DISTRICT—SPRINGWELLS SEWAGE PURIFICATION WORKS—*Continued.*

TABLE C.—THREE-HOURLY AVERAGE OF FILTER EFFLUENT.

	9-12 noon.	12-3 p.m.	3-6 p.m.	6-9 p.m.	Mean.
Chlorides, ...	3·4	4·0	3·8	4·4	3·9
Oxygen Absorbed, ...	1·46	2·00	2·80	4·26	2·63
Ammonia, Free as Nitrogen,...	·392	·600	·720	·608	·580
,, Albuminoid Nitrogen,	·072	·120	.184	·144	·130
Total Ammoniacal Nitrogen,	·464	·720	·904	·752	·710
Solids, Total, ...	46·4	55·2	56·0	55·2	53·2
,, Suspended, ...	4·3	6·8	4·5	4·3	4·9

TABLE D.—TWELVE-HOURLY AVERAGE OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Sewage.	Tank	Filter.
Chlorides, ...	4·9	4·2	3·9
Oxygen Absorbed, ...	5·20	3·27	2·62
Ammonia, Free as Nitrogen, ...	·744	·744	·664
,, Albuminoid Nitrogen, ...	·432	·256	·160
Total Ammoniacal Nitrogen, ...	1·176	1·000	·824
Solids, Total, ...	91·2	55·4	53·6
,, Suspended, ...	10·4	5·6	4·3

MIDDLE WARD DISTRICT—UDDINGSTON SEWAGE PURIFICATION WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 9 A.M. TO 9 P.M., 27TH AND 28TH FEBRUARY, 1907.

p.m.	Gallons.	a.m.	Gallons.
10.	11,250	10.	13,315
11.	11,025	11.	12,810
12.	10,650	12.	13,230
a.m. 1.	10,800	p.m. 1.	13,400
2.	10,800	2.	13,400
3.	10,650	3.	12,890
4.	10,650	4.	13,250
5.	10,650	5.	13,060
6.	10,800	6.	12,555
7.	11,100	7.	12,890
8.	11,250	8.	11,850
9.	12,725	9.	11,250

Total flow, 24 hours, 286,250 gallons.

MIDDLE WARD DISTRICT—UDDINGSTON SEWAGE PURIFICATION WORKS—*Continued.*

TABLE B.—AVERAGE HOURLY SAMPLES OF SEWAGE, TANK, AND FILTER EFFLUENT.

	Chlorides.			Oxygen Absorbed.		
p.m	Sewage.	Tank.	Filter	Sewage	Tank	Filter
10.	3·0	5·8	5·8	2·99	2·74	- ·06
11.	3·6	5·2	5·6	3·07	2·94	1·50
12.	4·4	5·2	5·0	2·20	2·33	1·74
a m						
1.	3·8	4·6	5·0	2·77	1·74	1·21
2.	3·0	.	4·4	2·23	.	1·50
3.	2·8	3·2	4·4	2·13	1·35	1·00
4.	3·0	3·0	4·4	2·17	1·35	·75
5.	3·0	2·8	3·4	1·97	1·13	·36
6.	3·4	2·6	3·8	1·94	1·27	·66
7.	3·6	2·8	4·0	1·44	1·27	·96
8.	4·2	3·8	4·2	2·45	1·45	1·14
9.	5·8	4·0	4·9	3·09	2·11	·94
10.	6·4	5·6	5·2	4·38	·77	1·33
11.	7·1	5·4	4·9	4·36	2·92	1·49
12.	5·8	6·4	5·2	5·58	3·67	1·70
p.m.						
1.	5·6	6·2	4·6	5·13	3·90	1·74
2.	6·4	6·0	5·0	4·63	3·47	1·52
3.	7·2	·4	5·6	5·21	3·94	1·69
4.	6·2	6·6	5·6	5·15	3·77	1·36
5.	7·2	7·2	5·6	5·37	·88	1·68
6.	7·0	5·4	6·0	4·74	3·84	1·34
7.	6·0	6·8	6·0	4·63	3·59	1·58
8.	6·0	6·6	5·6	4·30	3·60	·84
9.	5·6	6·4	4·4	3·70	3·19	1·07
Mean,	5·0	5·1	4·9	3·56	2·71	1·26

MIDDLE WARD DISTRICT—UDDINGSTON SEWAGE PURIFICATION WORKS—*Continued.*

TABLE D.—TWENTY-FOUR HOURLY AVERAGE SAMPLE OF SEWAGE, TANK AND FILTER EFFLUENT.

	Sewage.	Tank.	Filter.
Chlorides, ...	4·4	4·2	4·9
Oxygen Absorbed, ...	2·84	2·63	1·35
Nitrites as Nitrogen, ...	Nil.	Nil.	Trace.
Nitrates ,, ...	Nil.	Nil.	·24
Ammonia, Free Nitrogen, ...	1·920	2·000	·651
Ammonia, Albuminoid Nitrogen, ...	·341	·344	·195
Total Ammoniacal Nitrogen, ...	2·261	2·344	·846
Solids, Total, ...	82·2	40·54	37·7
,, Suspended, ...	41·7	11·30	5·3

TABLE F.—AVERAGE NIGHT (10 P.M.–6 A.M.) SAMPLE OF TANK AND FILTER EFFLUENT.

	Tank.	Filter.
Chlorides, ...	3·3	4·2
Oxygen Absorbed, ...	1·4	·96
Nitrites as Nitrogen, ...	Nil.	Abundant.
Nitrates ,.	Nil.	...
Ammonia, Free Nitrogen, ...	1·152	·768
,, Albuminoid Nitrogen, ...	·212	·128
Total Ammoniacal Nitrogen, ..	1·364	·896

TABLE G.—AVERAGE DAY (6 A.M.–10 P.M.) SAMPLE OF TANK AND FILTER EFFLUENT.

	Tank.	Filter.
Chlorides, ...	6·0	5·4
Oxygen Absorbed, ...	3·41	1·40
Nitrites as Nitrogen, ...	Nil.	Abundant.
Nitrates ,, ...	Nil.	...
Ammonia, Free Nitrogen, ...	1·720	1·192
,, Albuminoid Nitrogen, ...	·504	·262
Total Ammoniacal Nitrogen, ...	2·224	1·454

MIDDLE WARD DISTRICT—EAST KILBRIDE SEWAGE PURIFICATION WORKS.

Table A.—Hourly Flow of Sewage from 8 a.m. to 8 p.m., 31st August, 1909.

a.m.	Gallons	p.m.	Gallons
9.	2,339	3.	2,541
10.	2,837	4.	3,22[illegible]
11.	3,126	5.	2,730
12.	3,637	6.	2,421
p.m. 1.	3,514	7.	3,039
2.	3,259	8.	2,394

Total flow, 12 hours, 35,066 gallons.

Table C.—Average Sample of Effluent from each Filter.

	Filter 2	Filter 3	Filter 4	Filter 1.	Mean
Chlorides, ...	4·8	4·2	4·0	4·8	4·4
Oxygen Absorbed, ...	1·58	1·21	1·17	1·05	1·25
Nitrites as Nitrogen, ...	Nil.	Present.*	Nil.	Nil.	·000
Nitrates ,, ..	·041	·044	·043	·046	·043
Ammonia, Free Nitrogen,	1·144	·920	1·276	2·156	1·374
,, Albuminoid Nitrogen,	·136	·092	·132	·188	·137
Total Ammoniacal Nitrogen, ...	1·280	1·012	1·408	2·344	1·511
Solids, Total, ...	50·0	47·8	35·0	35·0	41·9
,, Volatile, ...	25·0	20·8	15·0	21·4	20·5
,, Suspended, ...	2·7	8·6	2·4	1·0	3·9

* Nitrites as Nitrogen = ·001.

Table D.—Average Twelve-Hourly Sample of Sewage, Tank, and Filter Effluent.

	Sewage.	Tank.	Filter.
Chlorides, ...	6·8	5·4	4·4
Oxygen Absorbed, ...	4·47	3·12	1·21
Nitrites as Nitrogen, ...	Nil.	Nil.	·000
Nitrates ,, ...	Nil.	Nil.	·044
Ammonia, Free Nitrogen, ...	2·272	1·784	1·200
,, Albuminoid Nitrogen,	·384	·304	·160
Total Ammoniacal Nitrogen, ...	2·656	2·088	1·360
Solids, Total, ...	60·0	44·0	35·0
,, Volatile, ...	37·0	38·0	15·0
,, Suspended,	12·8	6·0	3·4

LOWER WARD DISTRICT.—STEPPS SEWAGE PURIFICATION WORKS.

TABLE A.—HOURLY FLOW OF SEWAGE FROM 8 A.M. TO 8 P.M., 3RD AUGUST, 1909.

a.m.	Gallons.	p.m.	Gallons.
9.	1,998	3.	2,632
10.	2,632	4.	2,924
11.	2,924	5.	2,924
12.	3,216	6.	3,084
p.m. 1.	3,216	7.	3,518
2.	3,216	8.	2,924

Total flow, 12 hours, 35,208 gallons.

TABLE B.—AVERAGE HOURLY SAMPLE OF SEWAGE AND TANK EFFLUENT.

	Chlorides.		Oxygen Absorbed.	
a.m.	Sewage.	Tank.	Sewage.	Tank.
9.	5·2	5·0	4·20	2·42
10.	6·0	5·0	4·17	2·05
11.	5·6	5·4	4·70	2·53
12.	5·2	5·4	5·13	3·05
p.m. 1.	5·6	5·4	5·98	3·18
2.	7·0	5·4	5·50	3·07
3.	7·0	5·6	4·70	3·63
4.	7·0	6·2	5·22	3·17
5.	6·2	6·4	4·54	4·25
6.	5·0	6·4	5·32	4·24
7.	5·2	6·2	3·66	3·75
8.	7·4	5·8	3·89	3·55
Mean	6·0	5·7	4·75	3·24

LOWER WARD DISTRICT.—STEPPS SEWAGE PURIFICATION WORKS—*Continued*

TABLE C.—AVERAGE THREE-HOURLY SAMPLES OF TANK EFFLUENT

	[illegible]-11 a.m.	11-2 p.m.	2-5 p.m.	5-[illegible] p.m.	Mean
Chlorides, ..	5·2	5·4	6·0	6·2	5·7
Oxygen Absorbed,	2·36	3·14	4·06	4·10	3·41
Ammonia, Free as Nitrogen,	2·852	2·712	2·784	2·184	2·633
,, Albuminoid Nitrogen,	·240	·224	·400	·280	·286
Total Ammoniacal Nitrogen, ..	3·092	2·936	3·184	2·4[illegible]4	2·919
Solids, Total, ...	48·2	60·1	50·2	54·2	53·1
,, Volatile, ...	22·2	30·0	26·2	30·0	27·1
,, Suspended,	4·6	9·2	4·0	5·8	5·9

TABLE D.—AVERAGE TWELVE-HOURLY SAMPLE OF SEWAGE AND TANK EFFLUENT.

	Sewage	Tank
Chlorides, ...	6·0	5·7
Oxygen Absorbed, ..	4·76	3·20
Ammonia, Free as Nitrogen,	2·912	2·528
,, Albuminoid Nitrogen,	·448	·312
Total Ammoniacal Nitrogen,	3·360	2·840
Solids, Total, ...	70·0	52·0
,, Volatile,	43·2	20·0
,, Suspended,	26·0	4·6

II.—Samples taken from Streams receiving Effluent from Sewage Purification Works.

Samples taken to show the Effect of Discharge.

TABLE E.—BIGGAR BURN, TAKEN ABOVE AND BELOW THE OUTFALL FROM BIGGAR BURGH WEST END SEWAGE WORKS.

	Above.	20 yards below.	100 yards below.
Chlorides, ...	1·5	1·8	1·7
Oxygen Absorbed, ...	·22	·31	·24
Nitrites as Nitrogen, ...	Nil.	Trace.	Trace.
Nitrates ,, ...	·118	145	·168
Ammonia, Free as Nitrogen, ...	·004	·046	·038
,, Albuminoid Nitrogen,	·010	·016	·014
Total Ammoniacal Nitrogen, ...	·014	·062	·052
Solids, Total, ...	12·0	17·6	18·0
,, Volatile, ...	4·2	5·0	6·6
,, Suspended, ...	0·	0·	0·

TABLE E.—SOUTH CALDER WATER, TAKEN ABOVE AND BELOW THE OUTFALL, MOTHERWELL BURGH, COURSINGTON SEWAGE WORKS.

	100 yards above.	100 yards below.
Chlorides, ...	2·0	2·1
Oxygen Absorbed, ...	·50	·70
Nitrites as Nitrogen, ...	Faint Trace.	Trace.
Nitrates ,, ...	·068	·163
Ammonia, Free as Nitrogen, ...	·067	·084
,, Albuminoid Nitrogen, ...	·028	·041
Total Ammoniacal Nitrogen, ...	·095	·125
Solids, Total, ...	53·0	55·0
,, Volatile, ...	19·0	14·0
,, Suspended, ...	9·0	8·0

TABLE E. POWMILLON BURN, TAKEN ABOVE AND BELOW THE OUTFALL FROM STRATHAVEN SEWAGE WORKS.

	Above	20 yards below	100 yards below
Chlorides, ...	1·6	2·0	2·0
Oxygen Absorbed,	.58	·81	·81
Nitrites as Nitrogen, ...	Nil.	·001	·001
Nitrates ,, ...	·059	·194	·135
Ammonia, Free Nitrogen, ...	·000	·339	·212
,, Albuminoid Nitrogen,	·012	·054	·033
Total Ammoniacal Nitrogen,	·018	·393	·245
Solids, Total, ...	15·8	16·2	16·0
,, Volatile, ...	5·2	9·0	8·0
,, Suspended, ...	0·	7·5	7·4
Dissolved Oxygen, ccs. per litre,	6·96	5·06	5·28

TABLE E.—GARNKIRK BURN, TAKEN ABOVE AND BELOW THE OUTFALL FROM STEPPS SEWAGE WORKS.

	Above.	20 yards below	100 yards below.
Chlorides, ...	3·7	4·9	4·0
Oxygen Absorbed, ...	1·06	1·27	1·17
Nitrites as Nitrogen, } .	Present.	Abundant	Abundant.
Nitrates ,, } ...	·019	·051	·195
Ammonia, Free as Nitrogen, ...	·022	·676	·638
,, Albuminoid Nitrogen,	·019	·059	·057
Total Ammoniacal Nitrogen,	·041	·735	·695
Solids, Total, ...	41·0	41·2	43·2
,, Volatile, ...	15·0	17·0	20·0
,, Suspended, ...	0·	0·72	0·84
Dissolved Oxygen, ccs. per litre,	6·84	3·60	3·72

TABLE E.—KITTOCH WATER, TAKEN ABOVE AND BELOW THE OUTFALL FROM EAST KILBRIDE SEWAGE WORKS.

	20 yards above.	20 yards below.	100 yards below.
Chlorides, ...	1·4	2·0	2·2
Oxygen Absorbed, ...	·51	·67	·72
Nitrites as Nitrogen, ...	·000	·000	·000
Nitrates ,, ...	·032	·043	·036
Ammonia, Free Nitrogen, ...	·020	·314	·326
,, Albuminoid Nitrogen,	·018	·059	·073
Total Ammoniacal Nitrogen, ...	·038	·373	·399
Solids, Total, ...	36·8	35·0	40·4
,, Volatile, ...	16·2	13·0	18·4
,, Suspended, ...	0·	2·8	3·0
Dissolved Oxygen, ccs. per litre,	6·96	5·52	5·64

III.—Samples taken in connection with Legal Proceedings.

AIRDRIE BURGH.—Sewage-polluted Streams as leaving the Burgh and entering the County.—Samples taken on 20th February, 1908.

		1	2	3	4	5	6
Chlorides as Cl., ...		4·4	4·3	3·8	2·6	8·4	7·3
Oxygen Absorbed, ...		2·19	1·64	1·75	·80	9·51	7·32
Nitrates and Nitrites as N, ...		·232	·136	·192	·088	·272	·256
Ammonia as Nitrogen.	Free, ...	2·011	1·360	1·120	·663	2·640	2·550
	Albuminoid, ...	·295	·415	·240	·096	·530	·560
	Total, ...	2·306	1·775	1·360	·759	3·170	3·110
Solids.	Total, ...	48·9	41·6	44·6	30·4	57·8	52·5
	Volatile, ...	28·9	17·2	25·8	12·1	35·0	28·6
	Suspended, ...	9·4	4·8	8·6	1·2	17·6	5·6

PHYSICAL CHARACTERS.

1. Tributary of Brown Burn.—Turbid, opaque, type visible but not readable; blackish flocculent matter deposited sufficient to fill angle of bottle; faint sewage odour.
2. Brown Burn.—Turbid, opaque, type just readable; blackish flocculent matter deposited sufficient to half fill angle of bottle; faint sewage odour.
3. Eastmost tributary of Brown Burn.—Turbid, opalescent, type clearly seen; fair amount of greyish flocculent matter still in suspension, and slight film at top of bottle.
4. North Burn.—Transparent, opalescent; very small quantity blackish matter deposited.
5. South Burn.—Dark opaque liquid, type invisible; blackish flocculent matter filled angle of bottle to a depth of about ¼ inch; fair quantity solids still in suspension; distinct odour.
6. South Burn (mixed with some sewage also from Coatbridge Burgh).—Slightly clearer and about half suspended matter of No. 5; faint odour.

AIRDRIE BURGH.—Clear Streams in County in neighbourhood of Burgh.—Samples taken on 20th March, 1908.

		B	*C*	*D*	*E*
Chlorides as Cl., ...		1·7	1·9	10·2	7·2
Oxygen Absorbed, ...		·135	·305	·135	·365
Nitrates as Nitrogen, ...		·057	·052	·160*	·153
Ammonia as Nitrogen.	Free, ...	·007	·060	·027	·039
	Albuminoid, ...	·004	·019	·014	·021
	Total, ...	·011	·079	·041	·060
Solids.	Total, ...	36·5	49·3	55·9	62·5
	Volatile, ...	14·7	14·7	27·5	17·5

* Nitrites present

PHYSICAL CHARACTERS.

B. South Burn.—Transparent, opalescent; slightly turbid, due to granular matter in suspension.

C. North Burn.—Transparent, opalescent; slightly turbid, due to granular matter in suspension.

D. Nameless Burn.—Clear and transparent, very slight opalescence.

E. Gartsherrie Burn.—Transparent, opalescent; slight turbidity, due to granular suspended matter.

AIRDRIE BURGH.—Tabular Statement showing Degree of Pollution indicated by the amount of Unoxidised Nitrogen compared with the amount present in Clear Streams in neighbourhood of Burgh.

		1	2	3	4	5	6
Unoxidised Nitrogen.	In Free NH_3, ...	2·011	1·360	1·120	·663	2·640	2·550
	In Albuminoid NH_3,	·295	·415	·240	·096	·530	·560
	Total, ...	2·306	1·775	1·360	·759	3·170	3·110
	Excess, Actual, ...	2·259	1·728	1·313	·712	3·123	3·062
	Do., as Multiple,	49	38	29	16	68	66

AIRDRIE BURGH.—Sewage-polluted Streams as leaving the Burgh and entering the County.—Samples taken on 7th April, 1908.

		1	2	3	4	5	6
Chlorides as Cl, ...		5·4	4·4	4·2	3·4	8·4	7·4
Oxygen Absorbed, ...		3·37	2·78	1·95	1·04	11·63	9·65
Nitrates and Nitrites as N,		·203	·216	·376	·160	·128	·112
Ammonia as Nitrogen.	Free, ...	2·544	2·176	1·360	·712	2·592	1·712
	Albuminoid, ...	·416	·356	·256	·124	·744	·696
	Total, ...	2·960	2·532	1·616	·836	3·336	2·408
Solids.	Total, ...	59·0	49·1	38·9	31·6	68·6	67·4
	Volatile, ...	33·4	29·9	22·7	18·2	36·7	36·5
	Suspended, ...	16·4	11·6	8·9	2·0	14·0	16·0

PHYSICAL CHARACTERS.

1. Tributary of Brown Burn.—Turbid, opaque, type invisible ; greyish flocculent matter deposited sufficient to fill angle of bottle ; distinct odour.
2. Brown Burn.—As No. 1, slightly less turbid ; solids deposited half fill angle of bottle ; distinct odour.
3. Eastmost tributary of Brown Burn.—Fairly turbid, opalescent, type just visible ; fair quantity blackish matter deposited ; distinct odour.
4. North Burn.—Slightly turbid, opalescent, type visible ; small quantity of greyish flocculent matter deposited ; faint odour.
5. South Burn.—Dense, opaque, turbid liquid ; very large amount of dark-grey flocculent matter deposited ; strong sewage odour.
6. South Burn, after receiving some sewage also from Coatbridge Burgh.—Opaque, turbid liquid, type invisible ; large amount of dark-grey flocculent matter deposited ; distinct odour.

AIRDRIE BURGH.—Clear Streams in County in neighbourhood of Burgh.—Samples taken on 7th April, 1908.

		B	*C*	*D*	*E*
Chlorides as Cl, ...		1·4	1·6	7·9	5·1
Oxygen Absorbed, ...		·085	·200	·130	·280
Nitrates as Nitrogen, ...		·104	·126	·408*	·360
Ammonia as Nitrogen.	Free, ...	·003	·025	·011	·021
	Albuminoid, ...	·007	·017	·017	·020
	Total, ...	·010	·042	·028	·041
Solids.	Total, ...	25·7	36·4	64·4	35·0
	Volatile, ...	8·2	10·9	18·8	12·5

* Nitrites present.

PHYSICAL CHARACTERS.

B. South Burn.—Transparent, slightly opalescent; very small amount granular matter deposited.
C. North Burn.—Transparent, slightly opalescent; small amount granular matter deposited.
D. Nameless Burn.—Clear and transparent, very slight opalescence.
E. Gartsherrie Burn.—Faintly yellow in colour, transparent, opalescent, slightly turbid, due to finely-divided granular matter in suspension.

AIRDRIE BURGH.—Tabular Statement showing Degree of Pollution indicated by the amount of Unoxidised Nitrogen compared with the average amount present in Clear Streams in neighbourhood of Burghs.

		1	2	3	4	5	6
Unoxidised Nitrogen.	In Free NH_3, ...	2·544	2·176	1·360	·712	2·592	1·712
	In Albuminoid NH_3, ...	·416	·356	·256	·124	·744	·696
	Total, ...	2·960	2·532	1·616	·836	3·336	2·408
	Excess, Actual, ...	2·931	2·503	1·587	·807	3·307	2·379
	Excess as Multiple,	102	89	55	30	111	83

COATBRIDGE BURGH.—Sewage-polluted Streams as leaving the Burgh and entering the County.—Samples taken on 20th February, 1908.

		7	7a	8	9	10	11	12
	Chlorides as Cl, ...	5·6	3·0	8·6	3·2	4·2	6·8	6·2
	Oxygen Absorbed, ...	4·75	2·62	8·62	·72	2·66	2·85	2·14
	Nitrates and Nitrites as N, ...	·003	·036	·020	·064	·012	·017	·012
Ammonia as Nitrogen.	Free, ...	·120	·047	2·400	·807	·895	1·310	1·430
	Albuminoid, ...	·440	·030	·445	·176	·250	·143	·231
	Total, ...	·560	·077	2·845	·983	1·145	1·453	1·661
Solids.	Total, ...	102·0	65·8	60·1	46·8	61·2	51·9	64·1
	Volatile, ...	21·9	14·2	27·0	19·0	24·7	23·1	23·0
	Suspended, ...	4·2	8·6	14·0	3·8	4·0	9·6	10·4

PHYSICAL CHARACTERS.

7. Syke Burn.—Transparent, opalescent; small amount of very black flocculent matter deposited; distinct odour.
7A. North Calder.—Rather clearer than No. 7; faint odour.
8. South Burn.—Brownish opaque liquid, type invisible; brownish-black flocculent matter sufficient to fill angle of bottle; faint odour.
9. North Burn.—Transparent, opalescent; small quantity of greyish flocculent matter deposited; faint odour.

10. Gartsherrie Burn.—Turbid, opalescent, faint pinkish colour, type readable; small quantity blackish flocculent matter deposited; faint odour.
11. Luggie Burn.—Brownish opaque liquid, turbid, type invisible; small quantity of greyish black, almost granular matter deposited; distinct odour.
12. Luggie Burn, before confluence with North Calder.—Brownish liquid, turbid, opalescent, type readable; brownish flocculent matter deposited sufficient to fill angle of bottle, fair amount still in suspension; distinct odour.

COATBRIDGE BURGH.—Clear streams in County in neighbourhood of Burgh.—Samples taken on 20th March, 1908.

		B	*C*	*D*	*E*
Chlorides as Cl, ...		1·7	1·9	10·2	7·2
Oxygen Absorbed, ...		·135	·305	·135	·365
Nitrates as Nitrogen, ...		·057	·052	·160*	·153
Ammonia as Nitrogen.	Free, ...	·007	·060	·027	·039
	Albuminoid, ...	·004	·019	·014	·021
	Total, ...	·011	·079	·041	·060
Solids.	Total, ...	36·5	49·3	85·9	62·5
	Volatile, ...	14·7	14·7	27·5	17·5

* Nitrites present.

PHYSICAL CHARACTERS.

B. South Burn.—Transparent, opalescent, slightly turbid, due to granular matter in suspension.
C. North Burn.—Transparent, opalescent, slightly turbid, due to granular matter in suspension.
D. Nameless Burn.—Clear and transparent, very slight opalescence.
E. Gartsherrie Burn.—Transparent, opalescent, slight turbidity, due to granular suspended matter.

COATBRIDGE BURGH.—Tabular Statement, showing Degree of Pollution indicated by the amount of Unoxidised Nitrogen compared with the average Amount present in Clear Streams in neighbourhood of Burgh.

		7	7a	8	9	10	11	12
Unoxidised Nitrogen.	In Free NH_3, ...	·120	·047	2·400	·807	·895	1·310	1·430
	In Albuminoid NH_3, ...	·440	·030	·445	·176	·250	·143	·231
	Total, ...	·560	·077	2·845	·983	1·145	1·453	1·661
	Excess, Actual, ...	·513	·030	2·798	·936	1·098	1·406	1·614
	Do. as Multiple, ...	12	2	60	21	24	31	35

COATBRIDGE BURGH.—Sewage-polluted Streams as leaving the Burgh and entering the County.—Samples taken on 7th April, 1908.

		7	7a	8	9	10	11	12
Chlorides as Cl, ...	...	5·4	3·4	9·4	4·4	4·2	5·6	5·2
Oxygen Absorbed,	...	2·40	1·36	10·18	1·35	1·39	2·64	1·93
Nitrates and Nitrites as N,		·208	·080	·168	·110	·059	·048	·152
Ammonia as Nitrogen.	Free, ...	·345	·160	2·560	1·440	·608	1·162	1·216
	Albuminoid, ...	·144	·078	·624	·184	·352	·376	·145
	Total, ...	·489	·238	3·184	1·624	·960	1·538	1·361
Solids.	Total, ...	100·2	73·8	86·6	70·2	54·0	64·1	53·7
	Volatile, ..	21·[illegible]	51·6	39·6	26·7	21·5	20·5	21·3
	Suspended, ..	5·2	4·2	7·6	2·2	8·2	12·0	9·1

PHYSICAL CHARACTERS.

7. Syke Burn.—Opaque, turbid, type just visible; very small quantity dark-grey flocculent matter deposited; distinct odour.
7a. North Calder.—Opaque, turbid, type readable; very small quantity dark-grey flocculent matter deposited; faint odour.
8. South Burn.—Dense opaque liquid; very large amount of dark grey flocculent matter deposited; distinct sewage odour.
9. North Burn.—Opaque, turbid, type readable; small quantity greyish flocculent matter deposited; faint odour.
10. Gartsherrie Burn (within Coatbridge).—Opaque, turbid, type just visible; small quantity grey flocculent matter deposited; sewage odour.
11. Luggie Burn (at Langloan).—Opaque, turbid, type invisible; fair quantity greyish flocculent matter deposited; faint odour.
12. Luggie Burn (one mile below Coatbridge).—Opaque, turbid, type just visible; small quantity finely-divided greyish flocculent matter deposited; faint odour.

COATBRIDGE BURGH.—Clear Streams in County in neighbourhood of Burgh.—Samples taken on 7th April, 1908.

		B	*C*	*D*	*E*
Chlorides as Cl, ...	... ..	1·4	1·6	7·9	5·1
Oxygen Absorbed,	... ...	·085	·200	·130	·280
Nitrates as Nitrogen,	.. ...	·104	·126	·408*	·360
Ammonia as Nitrogen.	Free, ...	·003	·025	·011	·021
	Albuminoid, ...	·007	·017	·017	·020
	Total, ...	·010	·042	·028	·041
Solids.	Total, ...	25·7	36·4	64·4	35·0
	Volatile, ...	8·2	10·9	18·8	12·5

* Nitrites present.

Physical Characters.

B. South Burn.—Transparent, slightly opalescent; very small amount of granular matter deposited.
C. North Burn.—Transparent, slightly opalescent; small amount of granular matter deposited.
D. Nameless Burn.—Clear and transparent, very slight opalescence.
E. Gartsherrie Burn.—Faintly yellow in colour, transparent, opalescent; slightly turbid, due to finely-divided granular matter in suspension.

COATBRIDGE BURGH.—Tabular statement showing Degree of Pollution indicated by the amount of Unoxidised Nitrogen compared with the average amount present in clear stream in neighbourhood.

		7	7a	8	9	10	11	12
Unoxidised Nitrogen.	In Free NH_3, ...	·345	·160	2·560	1·440	·608	1·162	1·216
	In Albuminoid NH_3,	·144	·078	·624	·184	·352	·376	·145
	Total, ...	·489	·238	3·184	1·624	·960	1·538	1·361
	Excess, Actual, ...	·460	·209	3·155	1·595	·931	1·509	1·332
	Do., as Multiple, ...	17	8	110	56	33	53	47

MOSSEND IRON AND STEEL WORKS.—Samples taken 11th March, 1909, and Analysed 12th March, 1909.

Sample No. 1.—Water from Tank at bottom of Saturator (Hot-blast Tower).
,, ,, 2.—Crude Ammoniacal Liquor. Tank at foot of Acid Tower.
,, ,, 3.—Liquor from Tank at bottom of Cooling Tower, as overflowing to Shirrel Burn.
,, ,, 4.—Water from Tank outside Sulphate Still House, containing condensed vapours from sulphate still.
,, ,, 5.—Trade effluent as entering Tar Separators, side of Shirrel Burn.
,, ,, 6.—Trade effluent from filters at Tar Separators, and as entering Shirrel Burn.
,, ,, 7.—Liquor from gas cleansing plant at Power House.

Results, Parts per 100,000.

No.	Phenols.	Acidity as H_2SO_4.
1.	13·60	26·95
2.	731·00	4255·65
3.	285·00	58·80
4.	16·20	122·50
5.	135·20	36·75
6.	87·40	49·00
7.	278·00	183·75

Physical Characters.

No. 1.—Dense reddish brown liquid; very slight turbidity; slight spent liquor odour.
,, 2.—Yellowish brown liquid, containing considerable quantity of tar and oily matter; odour slightly acid.
,, 3.—Light yellowish colour, large quantity of tar and oily matter; distinct tarry odour.
,, 4.—Dark brownish liquid, colour rather deeper than No. 1; odour of spent liquor, stronger than No. 1.
,, 5.—Dark reddish brown liquid, turbid; odour of spent liquor and tar.
,, 6.—Appearance as No. 5; odour not so pronounced.
,, 7.—Dense yellowish opaque liquid; very distinct (gas) tar odour.

APPENDIX II.

EXTRACTS

FROM THE

FIFTH REPORT OF THE COMMISSIONERS APPOINTED TO INQUIRE AND REPORT WHAT METHODS OF TREATING AND DISPOSING OF SEWAGE (INCLUDING ANY LIQUID FROM ANY FACTORY OR MANUFACTURING PROCESS) MAY PROPERLY BE ADOPTED.

The Commissioners were appointed to inquire and report:—

I.—(1) What method or methods of treating and disposing of sewage (including any liquids from any factory or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of public health, and for the economical and efficient discharge of the duties of Local Authorities; and

(2) If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, the particular method of treatment and disposal to be adopted be determined; and

II.—To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage.

INTERIM REPORT (1901).

* * * * * * * *

We are satisfied that it is practicable to produce by artificial processes alone, either from sewage, or from certain mixtures of sewage and trade refuse, . . . effluents which will not putrefy, which would be classed as good according to ordinary chemical standards, and which might be discharged into a stream without fear of creating a nuisance.

* * * * * * * *

The general protection of our rivers is a matter of such grave concern as to demand the creation of a separate Commission, or a new department of the Local Government Board, which shall be a Supreme Rivers Authority, dealing with matters relating to rivers and their purification, and which, when appeal is made to them, shall have power to take action in cases where the Local Authorities have failed to do so.

SECOND REPORT (1902).

The second report was a formal document covering certain scientific papers, which were presented as an appendix to that report.

THIRD REPORT (1903).

Dealt with the relations between Local Authorities and manufacturers in regard to the disposal of manufacturing effluents.

The adaptation of the recommendations made in this Report to the legal, administrative, and other conditions of Scotland and Ireland is reserved for further consideration.

* * * * * * * *

FOURTH REPORT (1904).

Dealt with pollution of tidal waters.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

FIFTH REPORT (1908).

General Conclusion.

338. It is practicable to purify the sewage of towns to any degree required, either by land treatment or by artificial filters, and there is no essential difference between the two processes.

The main questions, therefore, to be considered in the case of a town proposing to adopt a system of sewage purification are, first, what degree of purification is required in the circumstances of that town, and of the river or stream into which its liquid refuse is to be discharged; and, secondly, how the degree of purification required can, in the particular case, be most economically obtained.

Removal of Suspended Matters.

We find that it is generally desirable to remove from the sewage, by a preliminary process, a considerable proportion of the grit and suspended matters before attempting to purify the sewage on land or filters.

Sedimentation Tanks.

339. *Quiescent Sedimentation.*—Two to three hours quiescence is usually sufficient to produce a tank liquor fairly free from suspended solids, but owing to the fact that some sewages contain a larger proportion than others of solids that settle very slowly, no general rule can be laid down as to the necessary period of quiescence. With this form of treatment the deposit in the tanks should be frequently removed.

Continuous Flow Sedimentation.—The amount of settlement effected does not depend alone upon the period of flow, but upon a number of other factors. If the tank liquor is to be treated upon filters of fine material, the period of flow should generally be from 10 to 15 hours. The tanks should be cleaned out at least once a week.

Septic Tanks.

340. All the organic solids present in sewage are not digested by septic tanks, the actual amount of digestion varying with the character of the sewage, the size of the tanks relative to the volume treated, and the frequency of cleansing. With a domestic sewage, and tanks worked at a 24 hours' rate, the digestion is about 25 per cent.

The liquor issuing from septic tanks is bacteriologically almost as impure as tho sewage entering the tanks.

Domestic sewage which has been passed through a septic tank is not more easily oxidised in its passage through filters than domestic sewage which has been subjected to chemical precipitation or simple sedimentation.

No definite rules can be laid down as to how long a septic tank should be run without cleaning. In the case of small sewage works (serving populations of, say, 100 to 10,000 persons), the tanks should generally be allowed to run, without cleaning, so long as the suspended matter in the tank liquor shows no signs of affecting the filters injuriously. For larger works it would generally be advisable to run off small quantities of sludge at short intervals of time.

The rate of flow through a septic tank is a matter in which the needs of each place require special consideration, but at few places should the sewage be allowed to take longer than 24 or less than 12 hours to flow through the tank. In no case should less than two tanks be provided, and they should be arranged so that, if necessary, one tank can be used alone.

As regards digestion of sludge and quality of tank liquor, a closed tank possesses no advantages over an open tank. There is less risk of nuisance if the tank and the feed channels to the filters are covered in.

By passing septic tank liquor through tanks of a size sufficient to hold about one quarter of the day's flow, with the addition of from 2 to 3 grains of lime per gallon to the liquor, the suspended solids in the liquor are materially reduced, a considerably larger quantity of the liquor can be treated per cube yard of filter, and the offensive character of the liquor is largely destroyed.

Chemical Precipitation.

341. In the case of sewages which contain certain trade waste, and strong sewages from water-closet towns, it is generally desirable to subject the sewage to some form of chemical treatment before attempting to

oxidise the organic matter contained in it. In most cases careful chemical precipitation materially aids the deposition of the suspended solids, and facilitates subsequent filtration.

No general rule can be stated with regard to the capacity of precipitation tanks. With continuous flow, an eight hours' rate is usually sufficient to produce a fairly good tank liquor from a domestic sewage of average strength.

If sewage is allowed to remain quiescent in the tank, two hours' settlement would usually suffice.

Relative Cost of Different Tank Treatments.

342. In the absence of special circumstances favouring a particular plan, it would appear that there is very little difference in annual cost between the various methods of tank treatment when taken in conjunction with the cost of subsequent filtration through percolating filters, assuming that the kind of filter adopted in each case is that which is best adapted to the particular tank treatment provided.

Filters.

343. Within ordinary limits, the depth of a contact bed makes, practically, no difference to its efficiency per cube yard.

We think that it would be generally inadvisable to construct contact beds of a greater depth than 6 feet or of a less depth than 2 feet 6 inches.

For practical purposes and assuming good distribution, the same purification will be obtained from a given quantity of *coarse* material, whether it is arranged in the form of a deep or of a shallow percolating filter, if the volume of sewage liquor treated per cube yard be the same in each case.

With regard to percolating filters of *fine* material, if the liquid to be purified were absolutely free from suspended and colloidal solids, and if thorough aeration could be maintained, the statement just made for filters of coarse material might possibly hold good for filters of fine material also. In practice, however, these conditions can scarcely be maintained with large rates of flow, and we think that the greatest efficiency can be got out of a given quantity of *fine* material by arranging it in the form of a shallow filter rather than of a deep filter. But we are not in a position to make an exact quantitative statement as to the difference in efficiency of the two forms.

344. The amount of sewage which can be purified per cube yard of contact bed or of percolating filter varies—within practical limits—nearly inversely as the strength of the liquor treated. This statement is based on the assumption that the size of the material of which the filter is composed is, in each case, suitable to the character of the liquor treated, and that the material is arranged at the proper depth to secure maximum efficiency.

Detailed particulars as to the amounts which can be treated per cube yard of filter are given on page 117.*

Taking into account the gradual loss of capacity of contact beds, a cubic yard of material arranged in the form of a percolating filter will generally treat about twice as much tank liquor as a cubic yard of material in a contact bed.

In the case of sewage containing substances which have an inhibitory effect upon the activity of micro-organisms, the working power per cube yard of filter of either type may be more nearly equal. This point, however, is not clearly established.

Percolating filters are better adapted to variations of flow than contact beds.

Effluents from percolating filters are usually much better aerated than effluents from contact beds, and, apart from suspended solids, are of a more uniform character. On emptying a contact bed, the first flush is usually much more impure than the average effluent from the bed.

The risk of nuisance from smell is greater with percolating filters than with contact beds.

With percolating filters there is apt to be nuisance from flies, especially with filters constructed of coarse filtering material. In the warmer months of the year, such filters swarm with members of the *Psychodidae*, which, though appearing to breed and develop in the filters, may usually be seen in large numbers on the walls of houses, or buildings close to or on the works.

Treatment of Sewage on Land.

315. There is no essential distinction between effluents from land and effluents from artificially constructed filters.

Effluents from those soils which are particularly well adapted for the purification of sewage contain only a very small quantity of unoxidised organic matter, and are usually of a higher class than effluents from artificial filters as at present constructed and used.

Effluents from soils which are not well adapted for the purification of sewage may often be very impure.

Sludging of Mill Dams.

316. In any case in which the Rivers Board should be of opinion that the sludging of a mill dam by turning the accumulated sludge into the stream would give rise to a nuisance, and that it would be financially practicable for the mill owner to adopt some other method of cleansing

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* The amounts which can be treated might be stated thus:—

Septic tank liquor,		if weak, on single-contact filters,	100-150	gallons per cube yard.	
,,	,,	if strong, on double-contact filters,	50-100	,,	,,
,,	,,	if weak, on percolating filters,	150	,,	,,
,,	,,	if strong, on percolating filters,	80	,,	,,

the dam, the Rivers Board should be empowered, by notice, to direct the mill owner not to turn the sludge into the stream.

It should be provided that any mill owner deeming himself aggrieved by such a direction, might, within some fixed period, appeal to the Central Authority. The decision of the Central Authority should be final.

Should any cases arise, in which it is important that the sludge should not be turned into the stream, but in which the Rivers Board are of opinion that the cost of adopting any other method of cleansing the dam would be prohibitive to the mill owner, we recommend that the Rivers Board should be empowered to represent the case to the Central Authority, and that the Central Authority should be empowered, after due enquiry, to direct that the sludge shall not be turned into the stream. If the Central Authority should be satisfied that the cost of adopting some other method of cleansing the dam would be greater than the mill owner could be reasonably called upon to bear, they should be empowered to direct that a portion of the cost should be borne by the Local Authorities whose districts would be benefited.

Effect of Trade Effluents on Sewage Purification.

347. All the trade effluents of which we have had experience interfere with or retard processes of purification to some extent, but we are not aware of any case where the admixture of trade refuse makes it impracticable to purify the sewage upon land or by means of artificial processes, although in certain extreme cases special processes of preliminary treatment may be necessary.

Nuisance from Smell.

348. All sewage works are liable, at times, to give off unpleasant smells; they should, therefore, be situated away from dwelling-houses, wherever this is practicable.

The nuisance is apt to be considerably greater where the sewage contains brewery refuse in any quantity; but, on the other hand, the presence of some trade effluents, such, *e.g.*, as iron salts or tarry matters, tends to render the process of purification less offensive.

The extent of the risk of nuisance depends, however, not only on the character of the sewage, but also on the method of treatment adopted.

General Observations bearing on a Choice of a Method of Sewage Treatment.

349. The selection of a method of sewage disposal should depend primarily on local conditions.

If a sufficient quantity of good land, to which the sewage can gravitate, can be purchased for about £100 an acre, land treatment would usually be the cheapest method to adopt.

In cases where only clay land is available, it would generally be cheaper and more satisfactory to provide artificial filters.

350. Given conditions favourable to each process, there is little difference as regards cost between any of the different forms of tank treatment when these are considered along with the cost of subsequent filtration.

Single contact will, generally, only yield a good effluent where the sewage to be treated is weak, and then only after good preliminary treatment. For the purification of partially settled weak sewage, and for well, as also for partially, settled sewage of average strength, if the case is one in which a good effluent is required, double contact is necessary, while if a strong sewage has to be treated, triple contact is necessary, unless the preliminary treatment is exceptionally good.

In nearly every case a greater rate of filtration per cube yard can be adopted if the material is arranged in the form of a percolating filter, than if it is used in contact beds. In many cases the rate of filtration through percolating filters may be double or nearly double what it could be with contact beds.

Where the liquor to be treated contains much suspended matter, it is usually advisable to construct filters, whether contact or percolating, with coarse filtering material. Where the preliminary treatment has effectively removed the greater part of the suspended matter, it is best to use fine material in the filters.

Storm Overflows on Branch Sewers.

351. Storm overflows on branch sewers should be used sparingly, and should usually be set so as not to come into operation until the flow in the branch sewer is several times the maximum normal dry weather flow in the sewer. No general rule can be laid down as to the increase in flow which should occur in the branch sewers before sewage is allowed to pass away by the overflow untreated. The Rivers Board, or in districts where there is no Rivers Board, the County Council should have power to require the Local Authority to alter any storm overflows which, in their opinion, permit of an excessive amount of unpurified sewage to flow over them. The Local Authority should have the right to appeal to the Central Authority in any case in which they consider that the requirement of the Rivers Board is unreasonable or impracticable of fulfilment.

The general principle should be to prevent such an amount of unpurified sewage from passing over the overflow as would cause nuisance.

Treatment of Storm Water Sewage at the Works.

352. As a general rule, special stand-by tanks (two or more) should be provided at the works, and kept empty for the purpose of receiving the excess of storm water which cannot properly be passed through the ordinary tanks. As regards the amount which may be properly passed

through the ordinary tanks, our experience shows that in storm times the rate of flow through these tanks may usually be increased to about three times the normal dry weather rate without serious disadvantage.

The overflow at the works should be made from these special tanks, and should be arranged so that it will not come into operation until the tanks are full.

Special filters which are only used in times of storm are not usually efficient, and should not be provided.

Any extra quantity of sewage arriving at the works in storms, which has to be filtered, should be treated on the ordinary filters, which should be made sufficiently large for the purpose.

As regards the size of the stand-by tanks, the amount of storm water sewage to be filtered, and the arrangements generally for dealing with the storm sewage at the outfall works, the Rivers Board or the County Council in areas in which no Rivers Boards have been established should have similar power to that which we have proposed in regard to overflows on branch sewers, and the Local Authority should have a similar right of appeal to the Central Authority.

In most cases it will probably suffice to provide stand-by tanks capable of holding one quarter of the daily dry-weather flow, and it will not be necessary to provide for *filtering* more than three times the normal dry-weather flow.

Under the arrangements which we recommend no storm sewage arriving at the outfall works would be discharged without some settlement.

Separate Systems of Sewers.

353. In any case in which a Local Authority wishes to adopt the separate system of drainage for the whole or any part of their district, they should apply to the Central Authority, and that Authority should be empowered to confer on the Local Authority, by order, such powers as are required.

As regards the powers that are required, the provisions which are generally contained in local Acts in respect of this matter seem to be defective. If separate sewers are provided, the Local Authority should have a clear power to enforce the provision of separate drains, but the local Acts to which our attention has been drawn do not modify the powers of the Local Authority under the general law in regard to bye-laws as to the drainage of houses. Moreover, the powers of the Local Authority should not necessarily be limited to new streets and new houses.

As a general rule, the expense of altering existing drains should fall on the Local Authority, and there may be some instances in which it would be equitable that they should bear some portion of the additional cost even in the case of new roads.

The Central Authority should, therefore, have power to include in their Order such provisions for the allocation of the cost as they consider equitable, having regard to the local circumstances.

Standards for Sewage Effluents.

354. Our terms of reference require us to have regard to the "*economical* and efficient" discharge of the duties of Local Authorities, and in view of the importance of not requiring a Local Authority to incur any further expenditure on sewage disposal than the circumstances of its area require, we feel strongly that the law should be altered so as to allow local circumstances to be taken into account.

We recommend that the Central Authority should determine the nature of the tests which are to be applied for the purpose of standards, and that it should be made the duty of the Rivers Board, or of the County Council in areas not under the jurisdiction of a Rivers Board, to determine, from time to time, subject to appeal to the Central Authority, what standards should be adopted.

In the first instance it would be convenient that the Central Authority should prescribe one standard for all non-tidal waters, in place of the existing statutory provisions. It would then rest with the Rivers Board or County Council to fix, subject to appeal to the Central Authority, a higher or lower standard in any case in which they were of opinion that the circumstances required or justified a different standard.

We further recommend that no action should be allowed to be brought in respect of damage alleged to be due to the discharge of an effluent which complies with the standard fixed for the water into which it is discharged, but that in such cases complaint should be made to the Central Authority, and, if a *prima facie* case is made out, that Authority should ascertain whether the complaint is well founded, and should be empowered to fix a different standard if the circumstances are shown to require it.

In cases where it is alleged that the effluent does not comply with the statutory standard, and that damage is caused by the discharge of such effluent, action should be brought in the ordinary Courts.

But any questions arising as to whether the effluent complies with the statutory standard, or as to whether the damage has been caused by the discharge of the effluent in respect of which complaint is made, should be referred by the Court to the Central Authority for determination. The costs of such determination should be borne by the parties to the action in such proportions as the Court may determine.

Power should be conferred on the Central Authority to suspend, from time to time, the operation of any standard, to allow time for the construction of works, or for any other reason which, in their opinion, justified such suspension.

Tests for Sewage Effluents in Relation to Standards.

355. According to our present knowledge, an effluent can best be judged by ascertaining, first, the amount of suspended solids which it contains, and, second, the rate at which the effluent, after the removal of the suspended solids, takes up oxygen from water.

In applying this test it is important that the suspended solids should be removed, and estimated separately.

For the guidance of Local Authorities we may provisionally state that an effluent would generally be satisfactory if it complied with the following conditions:—

(1) That it should not contain more than 3 parts per 100,000 of suspended matter; and

(2) That, after being filtered through filter paper, it should not absorb more than:

(*a*) 0·5 part by weight per 100,000 of dissolved or atmospheric oxygen in 24 hours;

(*b*) 1·0 part by weight per 100,000 of dissolved or atmospheric oxygen in 48 hours; or

(*c*) 1·5 parts by weight per 100,000 of dissolved or atmospheric oxygen in 5 days.

The Central Authority.

356. To secure the economical and efficient discharge of the duties of local authorities, and others, in regard to pollution, and adequately to protect the public health and the amenities of rivers, the statutory provisions in regard to these matters must be of an elastic character.

The conditions of different cases vary to such an extent that the necessary control cannot, in our opinion, be provided by any direct enactment which could be enforced by the ordinary Courts.

Throughout our Reports, this fact has been fully recognised, and we have proposed, in regard to many matters, that ultimate control should be vested in an adequately equipped Central Administrative Authority, and that, as far as practicable, the local Rivers Board should, in accordance with regulations framed by the Central Department, act as a first tribunal.

Among the more important questions which have to be dealt with under the new conditions of administration which we are contemplating, are the following:—

(i.) Disputes between local authorities and manufacturers as to the terms and conditions on which trade effluents shall be admitted into sewers.

(ii.) The control of shell-fish layings so as to prevent the taking of shell-fish for human consumption from positions in which they are liable to risk of dangerous contamination.

(iii.) The protection of water supplies from pollution.

(iv.) The collection of information as to the water supplies available in various parts of the country.

(v.) The collection of information as to the need of water in various parts of the country.

(vi.) The settlement of standards for different reaches of water.

(vii.) Conferring powers on local authorities, in suitable cases, to provide separate systems of sewers for surface water and to enforce the provision of separate drains.

(viii.) The settlement of questions as to the extra amount of sewage which a local authority should be required to treat during storms.

There are also numerous questions in regard to the purification of polluting liquids which, in the interests of the public, have still to be worked out, and it is essential that the Central Authority should be properly equipped for undertaking such special investigations as they may from time to time find necessary, and for collecting and collating the work done by others.

Since the date of our appointment considerable developments have taken place in regard to the disposal of sewage, and there is every reason to think that further changes will occur in the future.

Unless the Central Department keep in close touch with all such changes, and from time to time report on them, it is not possible for local authorities throughout the country fully to utilise the results of valuable work which is being done at many places, and hence, to perform their duties in the most economical as well as efficient manner.

The Position of our Inquiry.

357. In this Report we have dealt with the main question of what methods of sewage disposal may properly be adopted by local authorities. The remainder of our work will be chiefly concerned with the disposal of trade effluents when not mixed with sewage.

We have already investigated the disposal of distillery effluents, and shall issue a separate Report on this subject very shortly.

Concurrently with our investigation of the methods available for disposing of other trade effluents we shall continue our observations on the effect of discharging effluents of known composition into streams, with a view to reporting more fully on the question of standards and tests.

We are continuing, for another season, the experiments on the manurial value of sewage sludge, and are also making some observations on a few other points.